# Compressed Air
*Magazine*

DECEMBER 1946

●

**WELL-TAILORED CONCRETE BLOCK**

A 22-ton chunk taken from Coulee Dam Powerhouse in freeing Shasta generators

(See article, page 331)

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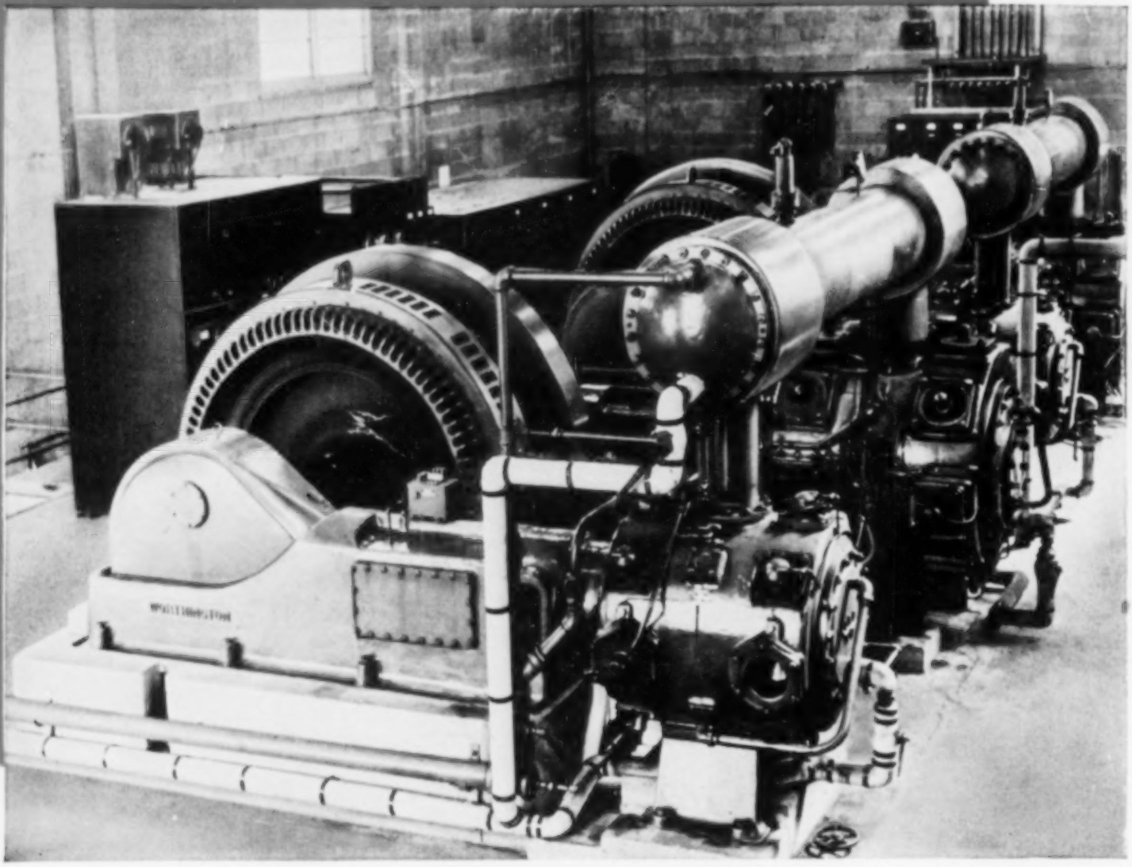
VOLUME 51 • NUMBER 12

NEW YORK • LONDON

**REDUCE** Compressor Operating Costs



YOUR compressors will operate at peak efficiency for extra hundreds of hours between overhauls—require fewer repairs and replacements—when you lubricate them with *Texaco Alcaid, Algol or Ursa Oil.*

*Texaco Alcaid, Algol and Ursa Oils* come in viscosity ranges to meet the requirements of every type and size of compressor. All are free of elements that lead to formation of hard carbon deposits—thus assure free rings, wide-opening, tight-shutting valves, open ports and clear air lines.

Benefits like these explain why experienced operators the world over have used *Texaco Alcaid, Algol and Ursa Oils* for years. Use them in your compressors—for better performance, reduced operating costs.

For Texaco Products and Lubrication Engineering Service, call the nearest of the more than 2300 Texaco distributing plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO
REG. T. M.

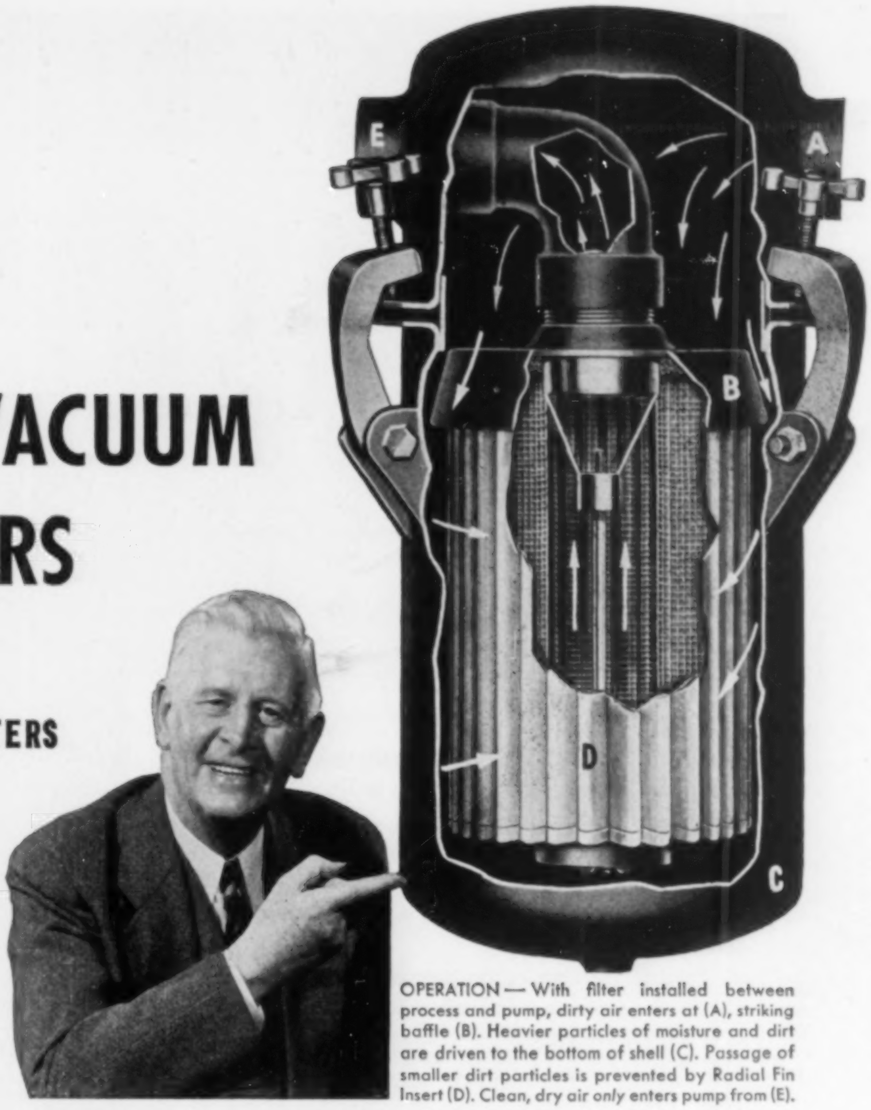
**TEXACO Lubricants**

**FOR ALL AIR COMPRESSORS AND TOOLS**

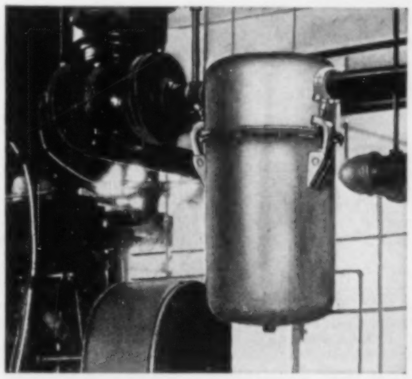
Tune in . . . TEXACO STAR THEATRE presents the NEW EDDIE BRACKEN SHOW every Sunday night. See newspapers for time and station.

# ELIMINATE VACUUM PUMP REPAIRS

## USE STAYNEW VACUUM FILTERS



OPERATION — With filter installed between process and pump, dirty air enters at (A), striking baffle (B). Heavier particles of moisture and dirt are driven to the bottom of shell (C). Passage of smaller dirt particles is prevented by Radial Fin Insert (D). Clean, dry air only enters pump from (E).



*A Staynew Vacuum Filter installed by a glass bottle manufacturer saved more than twice its cost every year. As a result, in a recent plant expansion, 10 additional Staynew Filters were placed in service to take advantage of these continuing savings.*

**COSTLY** vacuum pump repairs, caused by intake of abrasive material, are unnecessary. Such repairs can be positively prevented at relatively low cost by the installation of Staynew Vacuum Filters.

Today, hundreds of these filters save time and money in the food, glass, ceramic, steel, chemical and other industries.

Featuring the original Staynew Radial Fin Construction, the high efficiency of Staynew Vacuum Filters makes them ideal for laboratory use.

Models available for both wet and dry process pumps. Special materials can be furnished on request.

***COMPLETE INFORMATION ON REQUEST***

## DOLLINGER CORPORATION

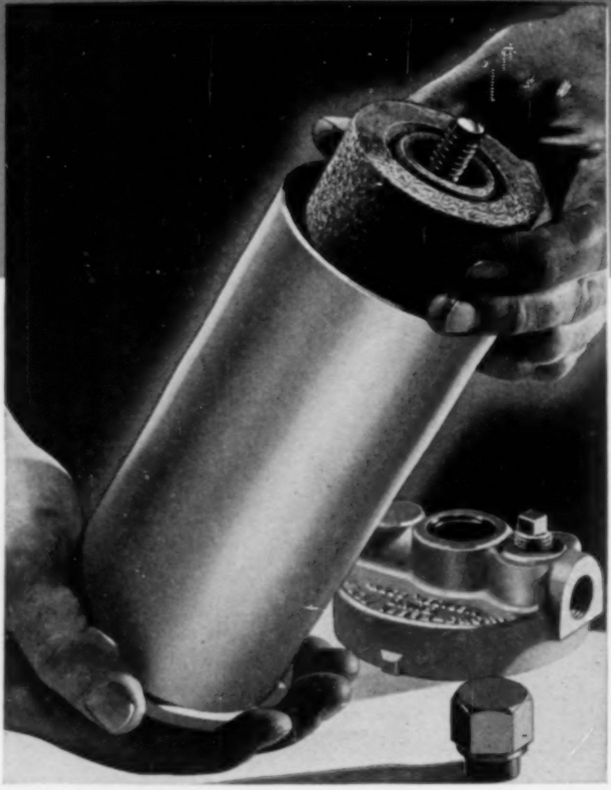
FILTERS EXCLUSIVELY SINCE 1921

7 CENTRE PK., ROCHESTER 3, N.Y. • REPRESENTATIVES IN PRINCIPAL CITIES

DOLLINGER
REG.
PROTECTOMOTOR
U.S. PAT. OFF.
STAYNEW FILTERS

# A NEW FILTER... A NEW PRINCIPLE

## *to cut cartridge replacement costs in half*



Cuno MICRO-KLEAN filters are available in a wide range of housing designs and replacement cartridges can be supplied in practically any desired length. Loosening a single nut disassembles housing for easy cartridge replacement on model illustrated.

Cuno's MICRO-KLEAN . . . a micronic-type filter made of molded fibre . . . uses Graded Density in Depth to collect more solids before needing replacement.

Here's a micronic filter that eats more dirt without choking.

Experience shows that the Cuno MICRO-KLEAN cartridge maintains efficiency twice as long as other micronic-type cartridges.

That's because the fibre concentration, travelling radially inward from the pressure-side surface to the discharge-side surface, is progressively greater — the spaces between fibres become smaller and more numerous.

### MAXIMUM EFFICIENCY— NO CHANNELING

The MICRO-KLEAN filter cartridge is resinous-impregnated molded fibre. Fibres of micronic diameter and graded length are oriented for uniform distribution and formed into a cylindrical cartridge,under conditions permitting a controlled variation of density radially to a pre-determined optimum standard. Thus, as the fluid flows through progressively smaller and more numerous interstices, the foreign particles penetrate to varying depths according to their size. This means that the cartridge can accommodate more solids without affecting flow — and will have a longer efficiency life before needing replacement.

This method of controlling structure gives the same range of density over the entire element. The natural arrangement of the fibre mixture is not disturbed laterally, so the fibres remain criss-crossed in all directions and porosity is uniform concentrically at any depth. This — and the fact that the fibre structure is preserved by resinous impregnation and polymerization — means maximum efficiency for every unit of filter area — and a *sure* protection against channeling.

Cartridges now available will remove all particles larger than 25 microns and the greatest proportion of particles down to 1 micron. (Coarser and finer filtration will be available soon). Use coupon to write for information in more detail.

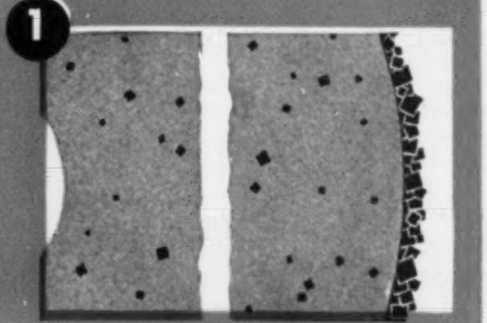
### WHAT MAKES MICRO-KLEAN LAST LONGER?

A special method of "felting" and impregnating micronic fibres, developed by Cuno engineers using the resources of a nationally known research foundation, has produced a depth-type micronic cartridge with *exclusive* advantages:

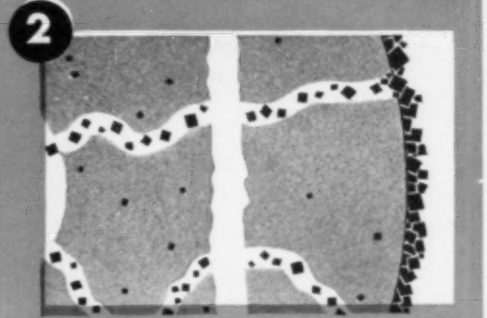
1. Graded Density in Depth, controlled concentrically and radially. Spaces between fibres become progressively smaller and more numerous approaching discharge surface. Smaller particles penetrate to varying depths — no sealing-over of inlet surface.

2. Resinous impregnated — each micronic fibre bonded in position — absolute protection against channeling, rupturing, shrinking or distortion.

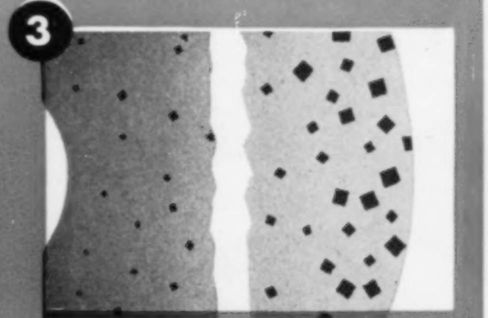
### *How* **MICRO-KLEAN** *Compares with Other Depth-Type Filters*



**SURFACE LOADING:** Minimum openings are same on pressure side and discharge side; therefore, dirt accumulation is largely on pressure side.



**CHANNELING:** Uncontrolled distribution of filter media in the element permits fluid to find channels, passing solids larger than specified.



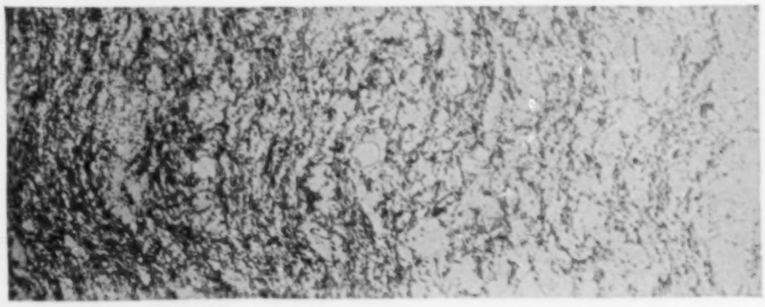
**MICRO-KLEAN:** Filter medium increases in density in direction of flow, from openings larger than rating to minimum openings on discharge-surface — more solids of all sizes collected within the element before stopping flow. Control of fibre distribution and bonding of fibres in correct position provide permanent channel-free structure.

CUNO

*Fluid Conditioning*

REMOVES MORE SIZES OF SOLIDS
FROM MORE TYPES OF FLUIDS

## GRADED DENSITY IN DEPTH



Photomicrograph shows progressively greater fibre density encountered by fluid as it passes from pressure surface (right) through depth of element to discharge surface (left).

## MICRO-KLEAN *greatly extends the range of applications for Cuno Fluid-Conditioning*

With MICRO-KLEAN, Cuno — whose filters are used more by Industry than any other brand — offers you the equipment and engineering service to help you handle successfully almost any fluid-cleaning requirement.

Cuno's famous all-metal continuously-cleanable AUTO-KLEAN removes all particles down to .0035″ from practically any fluids other than those containing highly abrasive solids. Cuno's wire-wound self-cleaning FLO-KLEAN is recommended for fluids containing large proportions of highly abrasive solids — mill river water, etc. Cuno's specially-designed COOLANT-KLEAN is for coolants used in precision grinding. Cuno's air filters remove unwanted solids, entrained moisture and oil from compressed air.

And now Cuno's MICRO-KLEAN extends the range of Cuno Fluid Conditioning down to micronic particles!

Cuno maintains a competent staff of engineers in twenty key cities across the country, who will cooperate with you personally and bring to you the active participation of Cuno's factory engineering staff. Sample fluid tests are conducted, either in our laboratory or in the field, upon arrangement.

Meanwhile, have us send you more information on Cuno MICRO-KLEAN. For convenience, use the coupon, listing the types of service in which you are interested.

**MICRO-KLEAN HOUSING DESIGNS**

Complete range from ⅜″ to 4″ inlet and outlet connections, handling up to 300 gpm. Other sizes available soon.

**MICRO-KLEAN CARTRIDGE SIZES**

1″ I. D. and 2¾″ O. D. standard at present. Standard lengths: 4″, 8″, 10″. Special lengths available for built-in installations or for housings already in service.

---

**CUNO ENGINEERING CORPORATION**
1717 South Vine Street, Meriden, Conn.

Please send me information on Micro-Klean Filter relative to the services checked.

☐ Lubricating Oil
☐ Hydraulic Oil
☐ Fuel Oil, Diesel
☐ Water and Water Solutions
☐ Compressed Air
☐ Acids
☐ Fuel Oil, burner (Domestic and industrial)

Send information on MICRO-KLEAN to handle the following: (Write any other fluid-cleaning problem here.)

..................................................................

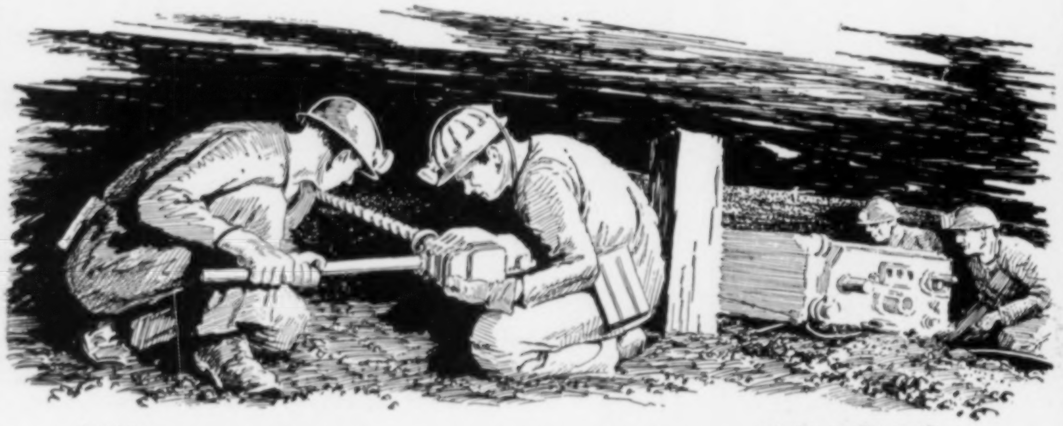
NAME ..............................................................

COMPANY ........................................................

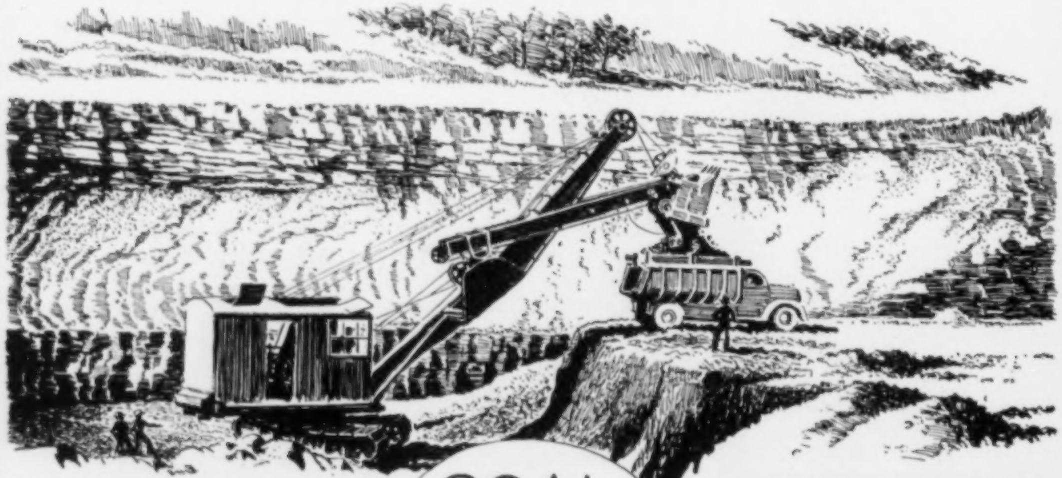
ADDRESS..........................................................

# *The Labors of a Modern Hercules* – COAL

COAL, MARVELOUS GIFT TO MANKIND,
PRODUCED THROUGH AEONS OF TIME BY THE UNBELIEVABLE ALCHEMY OF NATURE;
COAL, "THE STONES THAT BURNED LIKE WOOD COLES" IN THE FAR-OFF DAYS OF PERSIA AND GREECE;
COAL, WHICH BARELY WARMED ROMAN LEGIONS IN BRITAIN, AND FITFULLY FLAMED THROUGH DARK AGES OF ENGLISH HISTORY,
UNTIL HARDY HUMAN MOLES AT NEWCASTLE-ON-TYNE RECOVERED THE BURIED FUEL FOR HOME AND INDUSTRY.

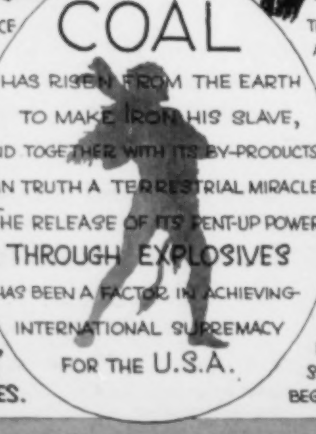


COAL, EARTH-BOUND GIANT, RELEASED FROM ITS PRIMORDIAL PRISON BY EXPLOSIVES,
IS FOUND IN GREATER ABUNDANCE IN THE U.S. THAN ANY OTHER COUNTRY ON THE GLOBE,
HALF THE KNOWN WORLD RESERVES BEING LOCATED HERE.



COAL, WHERE FOUND IN VAST NEAR-SURFACE SEAMS, IS STRIP-MINED BY GARGANTUAN MONSTERS AND EXPLOSIVES.

THE EARLY MINER, PICKING HIS STINT OF COAL, WOULD MARVEL AT TODAY'S MASS PRODUCTION BROUGHT ABOUT BY MACHINERY AND EXPLOSIVES.



COAL
HAS RISEN FROM THE EARTH
TO MAKE IRON HIS SLAVE,
AND TOGETHER WITH ITS BY-PRODUCTS,
IS IN TRUTH A TERRESTRIAL MIRACLE.
THE RELEASE OF ITS PENT-UP POWER
THROUGH EXPLOSIVES
HAS BEEN A FACTOR IN ACHIEVING
INTERNATIONAL SUPREMACY
FOR THE U.S.A.

THE COMBINED TONNAGE OF UNDERGROUND AND OPEN-PIT MINING PRODUCES ENOUGH EACH YEAR TO BUILD A CHINESE WALL OF COAL AROUND THE U.S.

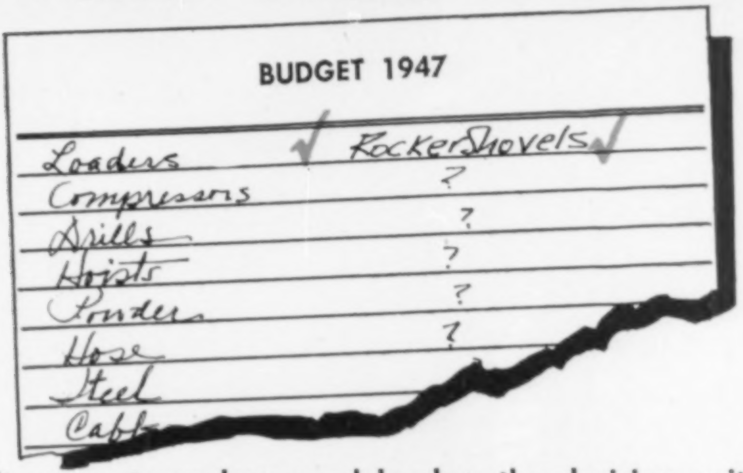
PIONEERS, WRESTING SLABS OF COAL FROM SURFACE OUT-CROPPINGS, WERE THE TINY BEGINNING OF TODAY'S GIGANTIC STRIP MINING.

**HERCULES**

EXPLOSIVES DEPARTMENT
*HERCULES POWDER COMPANY*
INCORPORATED
WILMINGTON 99, DELAWARE

XR-69

# EIMCO *RockerShovels* ARE FIRST CHOICE


BUDGET 1947
Loaders ✓ RockerShovels ✓
Compressors ?
Drills ?
Hoists ?
Powder ?
Hose ?
Steel
Cabl

When it comes to underground loaders the decision, without question, is sure to be RockerShovels because thousands of these Eimco Loaders in use throughout the world have proved their superiority. Here are a few of the outstanding features that make the RockerShovel first choice.

## *RockerShovels Are:*

**SIMPLE:** They are constructed with the fewest number of parts (about half the parts used on other types).

**FAST:** The average cycle of the bucket in the hands of an experienced operator is only 6 or 7 seconds.

**POWERFUL:** These machines are powered by 5 cylinder air motors of the piston type. The Model 21 and 40 are available with electric motors.

**HEAVY DUTY:** Every part is made for 100% overload to withstand 24 hour continuous mining service.

**DEPENDABLE:** RockerShovels are well known for their staying power underground. Many stay from 4 to 7 years underground without coming out for maintenance.

**TROUBLEFREE:** The ruggest construction of the machine which incorporates all heavy steel parts and anti-friction bearings have reduced the average maintenance costs to less than one cent per ton loaded.

**SAFE:** Eimco RockerShovels are constructed to protect both the operator's hands and feet from accidents that are common with ordinary loaders.

**ACCESSIBLE:** Control parts are grouped conveniently in a cast manifold fitting on the side sheet of the machine.

**PATENTED:** Patented features which make the RockerShovel outstanding in its field include low headroom provided by patented curve of rocker-arm, completely enclosed positive automatic centering, multi-step digging width control and automatic neutralizing center chain pull.

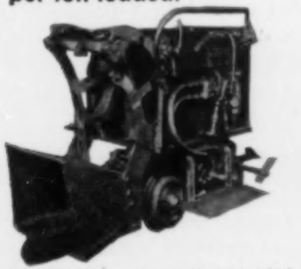
Write for more information on RockerShovels

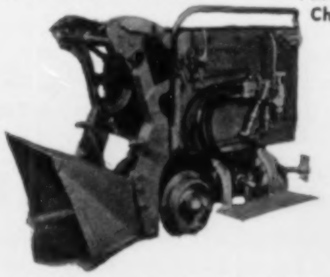
**EIMCO**

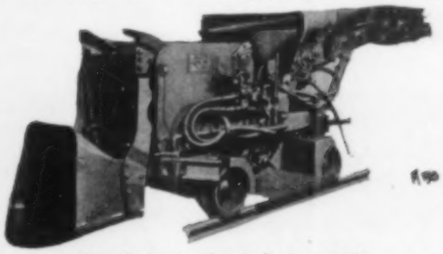
THE EIMCO CORPORATION

*The World's Largest Manufacturer of Underground Rock Loading Machines*

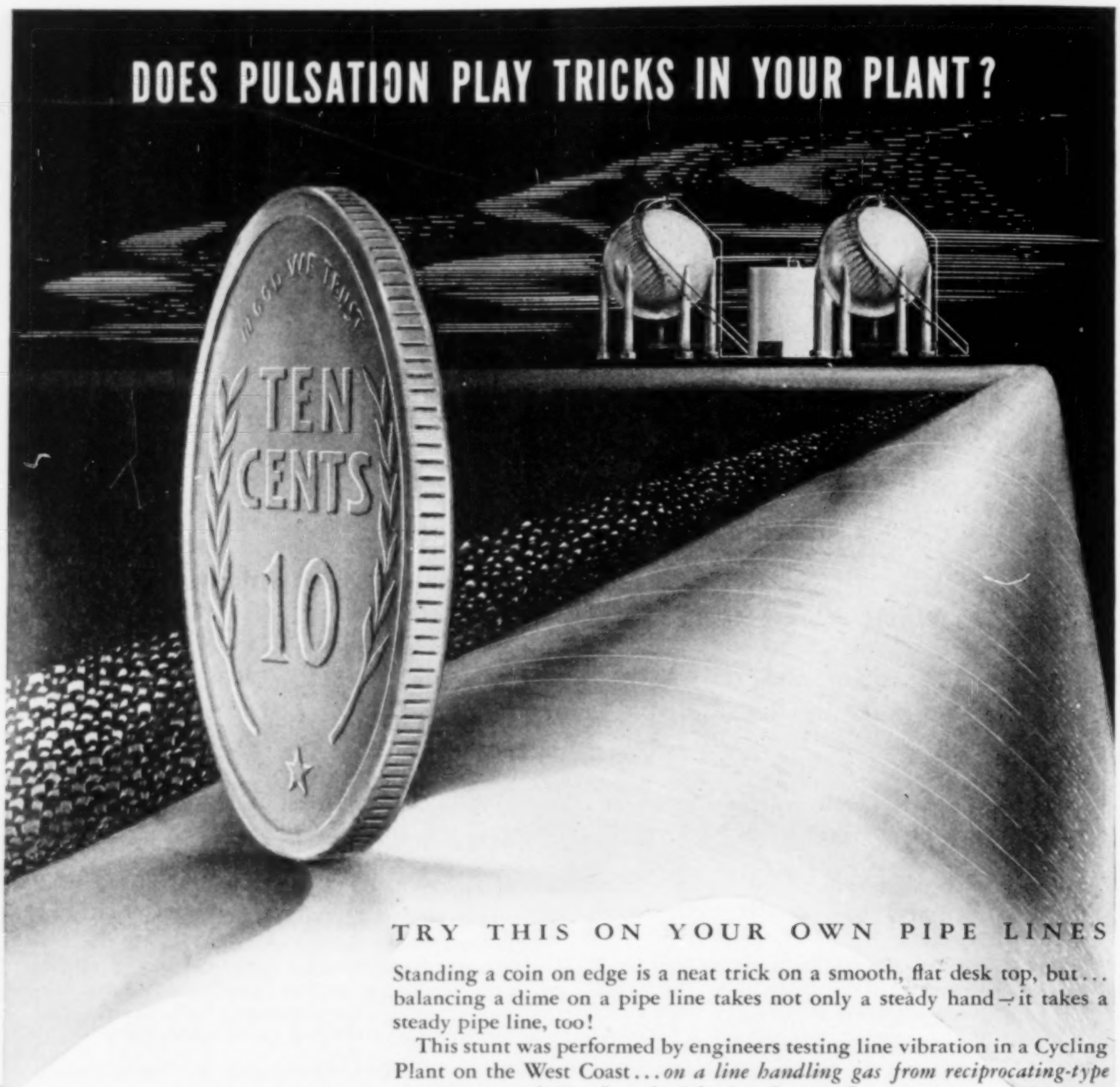
Executive Offices and Factories — Salt Lake City 8, Utah:
Branches — 67 Wall St., New York 5 — 111 W. Washington St., Chicago 2 — Mills Bldg., El Paso — 1217 - 7th St., Sacramento 14


Model 12B—Write for Bulletin L-1010


Model 21—Write for Bulletin L-1011


Model 40—Write for Bulletin L-1009

# DOES PULSATION PLAY TRICKS IN YOUR PLANT?



## TRY THIS ON YOUR OWN PIPE LINES

Standing a coin on edge is a neat trick on a smooth, flat desk top, but... balancing a dime on a pipe line takes not only a steady hand—it takes a steady pipe line, too!

This stunt was performed by engineers testing line vibration in a Cycling Plant on the West Coast... *on a line handling gas from reciprocating-type compressors at 4000 psi. and with pipe clamps off.*

FLUOR Pulsation Dampeners, installed as original equipment on each high pressure discharge lateral in this plant, convert pulsative flow—inherent when reciprocating compressors are used—to a smooth, steady stream. By installing FLUOR Pulsation Dampeners *when the plant was built,* vibration caused by pulsative flow was stopped before it could get started. If you are planning to build a new plant or additions to your present facilities, it will pay you to investigate the FLUOR Pulsation Dampener now.

FLUOR Pulsation Dampeners eliminate the expense of accessory equipment to absorb vibration, such as clamps, anchors and expansion chambers; they save the extra cost of over-sized pipe and extra bends and effect substantial reductions in horsepower cost. This means a saving in original plant cost which more than pays for the FLUOR Pulsation Dampeners installed, plus lower operating and maintenance costs for the life of the plant.

WRITE FOR
FLUOR GENERAL CATALOG
NO. 46

BE SURE WITH FLUOR
fc
SINCE 1890

**FLUOR** PULSATION DAMPENER

THE FLUOR CORPORATION LTD., 2500 South Atlantic Boulevard, Los Angeles 22
NEW YORK • PITTSBURGH • KANSAS CITY • HOUSTON • TULSA • BOSTON

ENGINEERS • MANUFACTURERS • CONSTRUCTORS

A-O
RUBBER FRAME GOGGLES
American Optical Co.

**Have Sweep-Vision Lens**

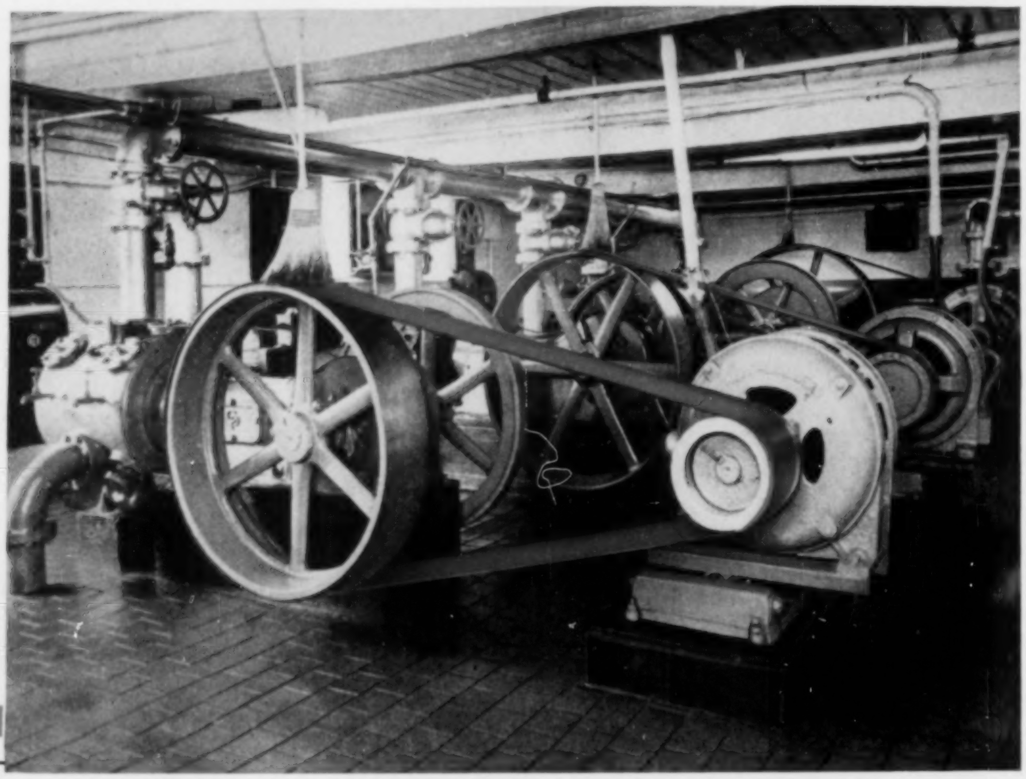
**Provide Protection against Chemical and Dust Hazards**

The new A-O Rubber Frame Goggle has a single large acetate lens which provides exceptional wide-angle vision. Frame is molded from non-irritating, acid-resisting synthetic rubber, which will stand up under long, hard wear. It is scientifically designed to conform to face contours, providing an acid- and dust-tight fit. Cushioned and ventilated for maximum comfort. May be worn over personal prescription glasses. Especially recommended for maintenance men on acid lines and storage batteries; for workers on metal plating baths, foundry shake-out, railroad car and coal handling apparatus cleaning, and in ship holds and engine cabs where dust is a dangerous factor. Send for bulletin which fully describes the various outstanding features of this new A-O development.

American Optical
COMPANY
*Safety Division*

SOUTHBRIDGE, MASSACHUSETTS
BRANCHES IN PRINCIPAL INDUSTRIAL CITIES

*How to Maintain Efficiency*
IN YOUR COMPRESSOR DRIVES



Your compressors are very important. Their best performance can be secured only through the use of the best type of drive . . . a drive that is absolutely reliable . . . that will not slip and that requires a minimum of attention. You can secure these qualities in a Rhoads Tannate-Rockwood short center drive which automatically maintains correct tension with varying loads. The weight of the motor on the pivoted motor base cares for load fluctuations. Rhoads Tannate leather belting has proven to be exceptionally reliable and efficient. Tannate tannage gives the physical properties needed for exacting performance of this kind. Investigate this drive. See it at the New York Power Show in December. Ask us for more information.

*Established 1702*
**J. E. RHOADS & SONS**
35 N. SIXTH ST., PHILA. 6, PA.
NEW YORK CHICAGO ATLANTA

RHOADS *Tannate* WATERSHED LEATHER BELTING *Tannate-Rockwood* SHORT CENTER DRIVE

Shaping Industrial Prosperity through

Metal MINING

TUNGSTEN
ZINC
IRON
COPPER
GOLD
LEAD
MOLYBDENUM
LEAD
IRON
ZINC
ZINC
SILVER
BAUXITE
IRON
COPPER

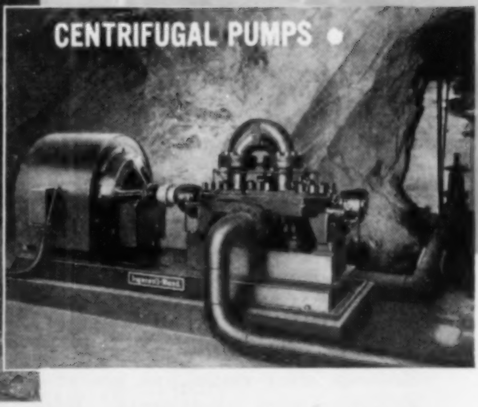
A NATIONAL MINERAL POLICY

Compiled by Evan Just, Editor Engineering and Mining Journal. It includes:

1. Tax policies that encourage exploration and development.
2. Conservation through efficiency and maximum use.
3. A logical balance between domestic production and imports.
4. Modernization of protection for domestic industry.
5. Stockpiles for security and as economic cushions.
6. Enlightened participation in mineral cartel activities.
7. Improved government service to American operations abroad.
8. A public-land policy that fosters development.

Received FIRST AWARD for Editorial Achievement for best single article or editorial during year ended July 31, 1945.

ROCK DRILLS •



AIR COMPRESSORS •

*A general condition of industrial and commercial activity in which goods and money are comparatively plentiful*—that is a definition of PROSPERITY.

The metals available to build goods and wealth, *while in the ground,* represent only the potentials of PROSPERITY.

The first value is added when excavation starts. A further value accrues in refining. Step by step, values are introduced through fabricating, assembling, finishing, shipping, selling . . . resulting in wide distribution of industrial and commercial employment.

Thus mining and processing with Ingersoll-Rand equipment initiate the spiral . . . the prelude to PROSPERITY.

IR

*Mining Equipment*

ROCK DRILLS • JACKBITS • AIR TOOLS
SLUSHER HOISTS •
COMPRESSORS • PUMPS •
DIESEL ENGINES • BLOWERS

**Ingersoll-Rand**

11 Broadway, New York 4, N. Y.

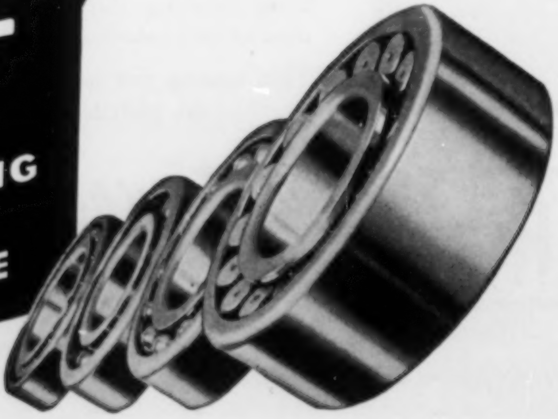
● BUILT BY
CATERPILLAR
TRACTOR CO.

# ROLLING *Tractor* RELIABILITY

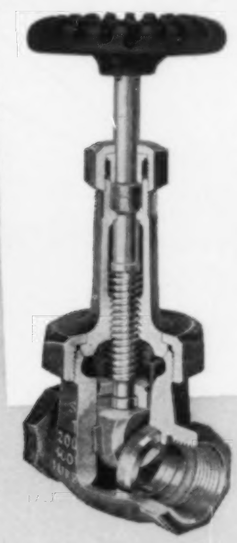
Building dams to store stock water is only one of many tasks that Caterpillar Tractors are doing with the help of SKF Bearings. They ***push*** and ***pull*** on Industry's toughest jobs. And on their vital rotating parts, SKF Bearings start easily, run almost effortlessly for years, and never need adjustments. Their only requirement is occasional lubrication, and they maintain their initial close tolerances. For over a long period of years, SKF has applied its engineering skill to the development of ball and roller bearings. With such long and diverse experience, an SKF representative can help you select the right bearing for the right place. 6114

SKF INDUSTRIES, INC., PHILA. 34, PA.

**SKF**
**Puts the**
**RIGHT BEARING**
**in the**
**RIGHT PLACE**



# high-value highlights of the fairbanks bronze valve line



**MANY VALVES FOR MANY SERVICES** can be selected from the broad range of Fairbanks Bronze Valves highlighted here. Made for pressures from 125 to 300 pounds, Fairbanks Valves are available with screwed or flanged ends also with Faircoseal ends for Silbraz joints.

The Fairbanks distributor performs **many services for many industries.** Adequate stocks of all types of piping and mill supplies as well as Fairbanks Valves are available as needed, day or night.

Consult your distributor for all valve installation requirements.

Fig. 0236

**200 Pound UNION BONNET BRONZE GATE VALVE**

**Rising stem — renewable nickel alloy seat and wedge.**

The superior hardness and corrosion-resistance of nickel alloy wedge and seats, in addition to the sturdy hexagonal union nut, with radial body bonnet joint make this new valve particularly adapted to long, satisfactory service, with low maintenance cost. Also available in non-rising stem type and with integral seats.

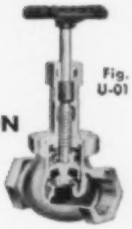


Fig. U-01

**COMPOSITION DISC Globe and Angle**

Union bonnet — integral seats — 150 and 200 pound pressures. For services requiring quick disc renewal.

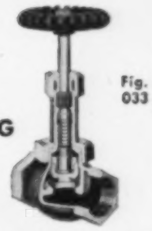


Fig. 033

**REGRINDING Globe, Angle and Cross**

Bronze disc—integral seat—union bonnet—200 and 300 pound pressures. For higher pressure service where composition discs are not satisfactory.

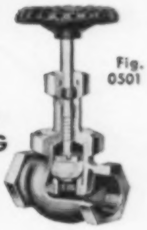


Fig. 0501

**RENEWABLE REGRINDING Globe and Angle**

Nickel alloy seat and disc—union bonnet—200 and 300 pound pressures. For more severe services on steam, water, oil, gas and air.

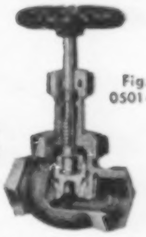


Fig. 0501-P

**PLUG DISC AND SEAT Globe and Angle**

Renewable hardened nickel alloy seat and disc—200 pound pressure. For throttling and other service requiring close regulation of flow.

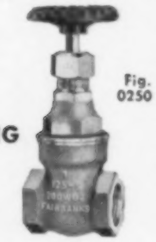


Fig. 0250

**NON-RISING STEM Gate Valves**

Screwed bonnet — solid wedge — taper seat 125, 150 and 300 pound pressures. For full flow of steam, water, oil and gas.

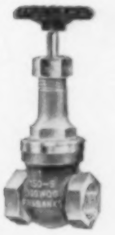


Fig. 0228

**RISING STEM Gate Valves**

Screwed bonnet — split wedge — solid wedge for 125 and 150 pound pressures. For steam, water, oil and gas.

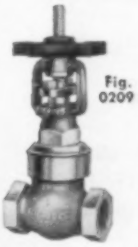


Fig. 0209

**OUTSIDE SCREW AND YOKE Gate Valves**

Screwed bonnet — solid wedge — taper seat — 150 and 300 pound pressures, where operating threads must not contact fluids.

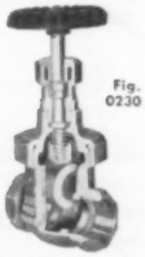


Fig. 0230

**UNION BONNET Gate Valve**

Non-rising stem — nickel alloy wedge—integral seat—200 pound pressure. For higher pressures on steam, water, oil and gas.

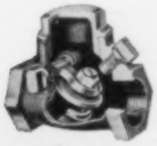


Fig. 0601

**SWING CHECK VALVES**

Horizontal—renewable bronze disc—125, 150, 200 and 300 pound pressures. For maximum flow of steam, water, oil and gas.

Fig. 0616

**LIFT CHECK VALVES**

Horizontal—angle. Renewable composition disc for 150 pounds —regrinding bronze disc for 200 and 300 pounds. To prevent return flow. Positive vertical lift of discs.

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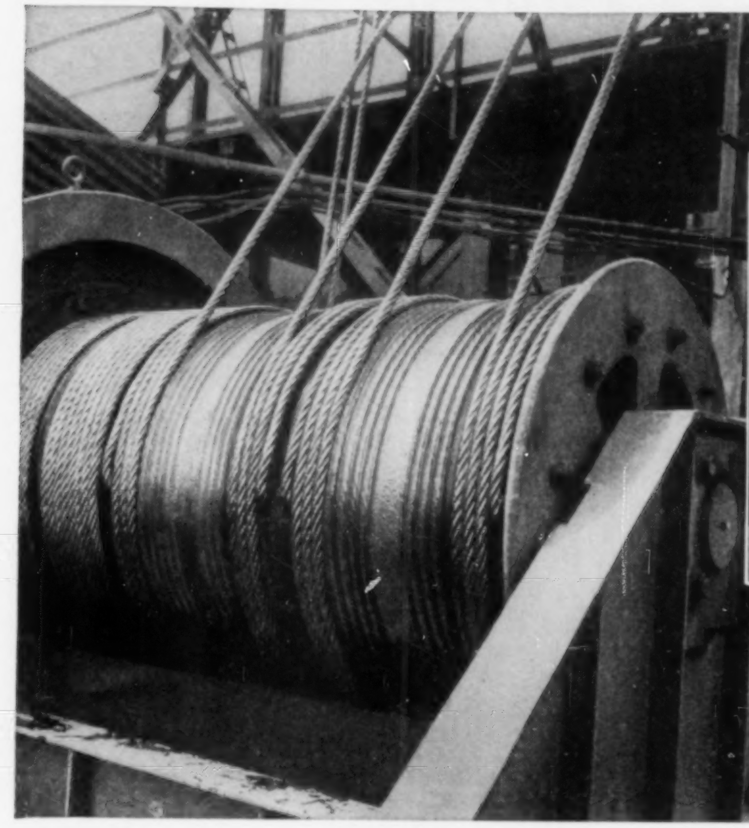

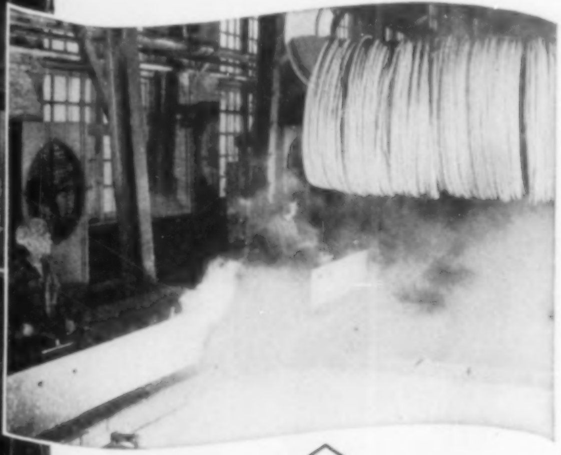

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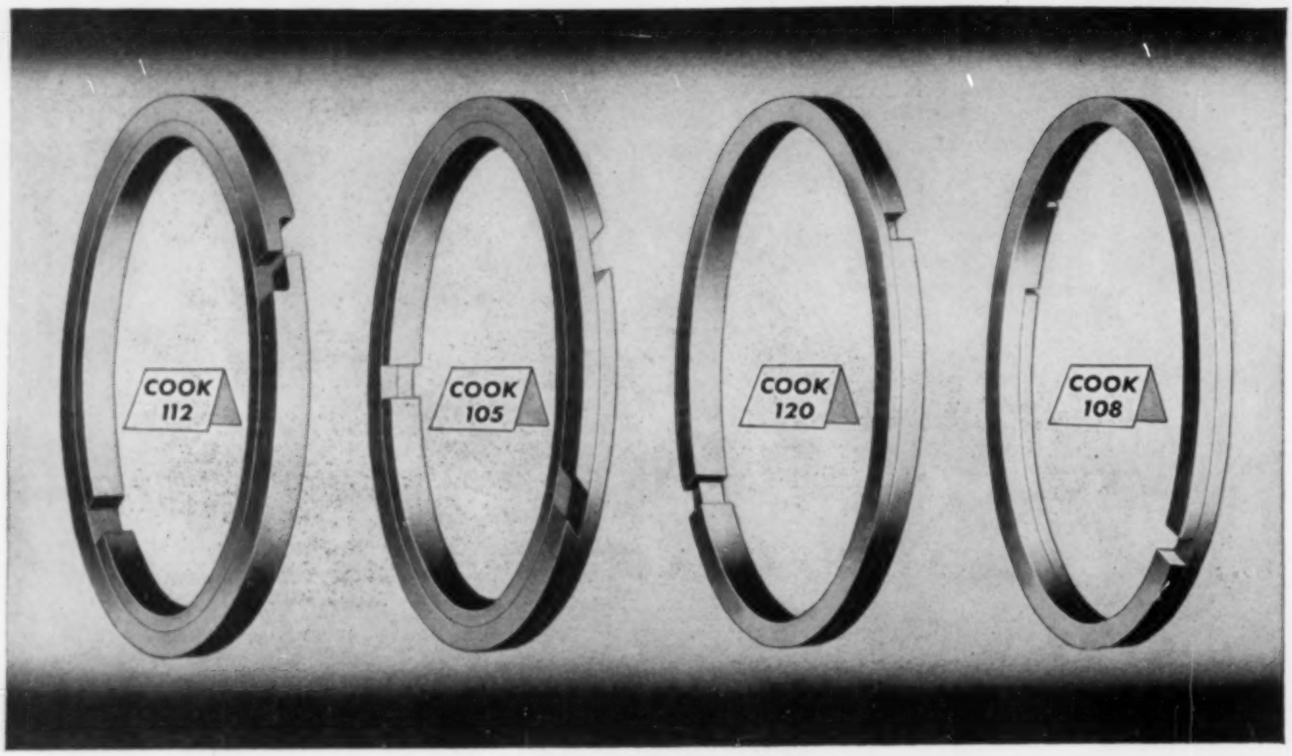

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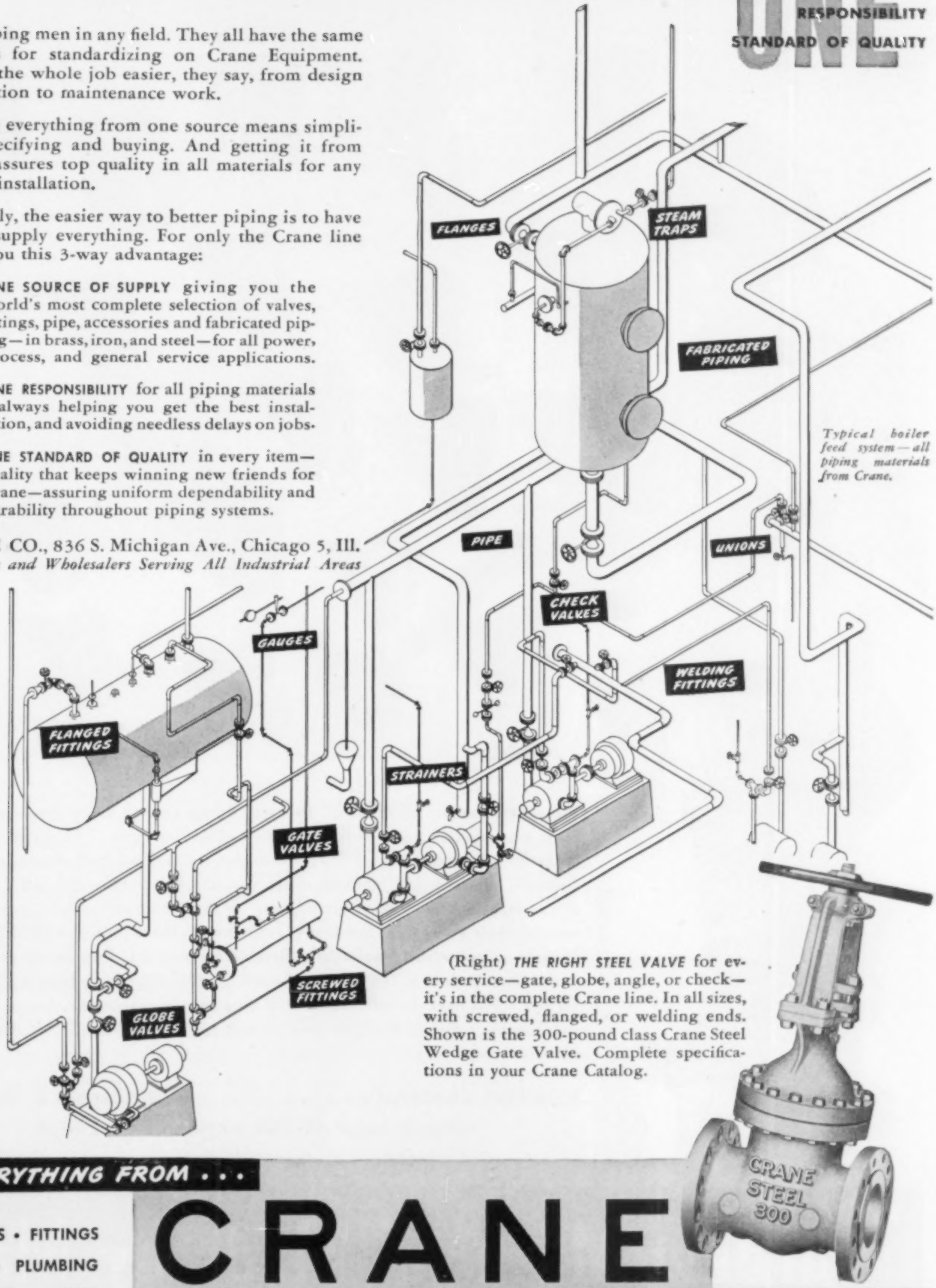

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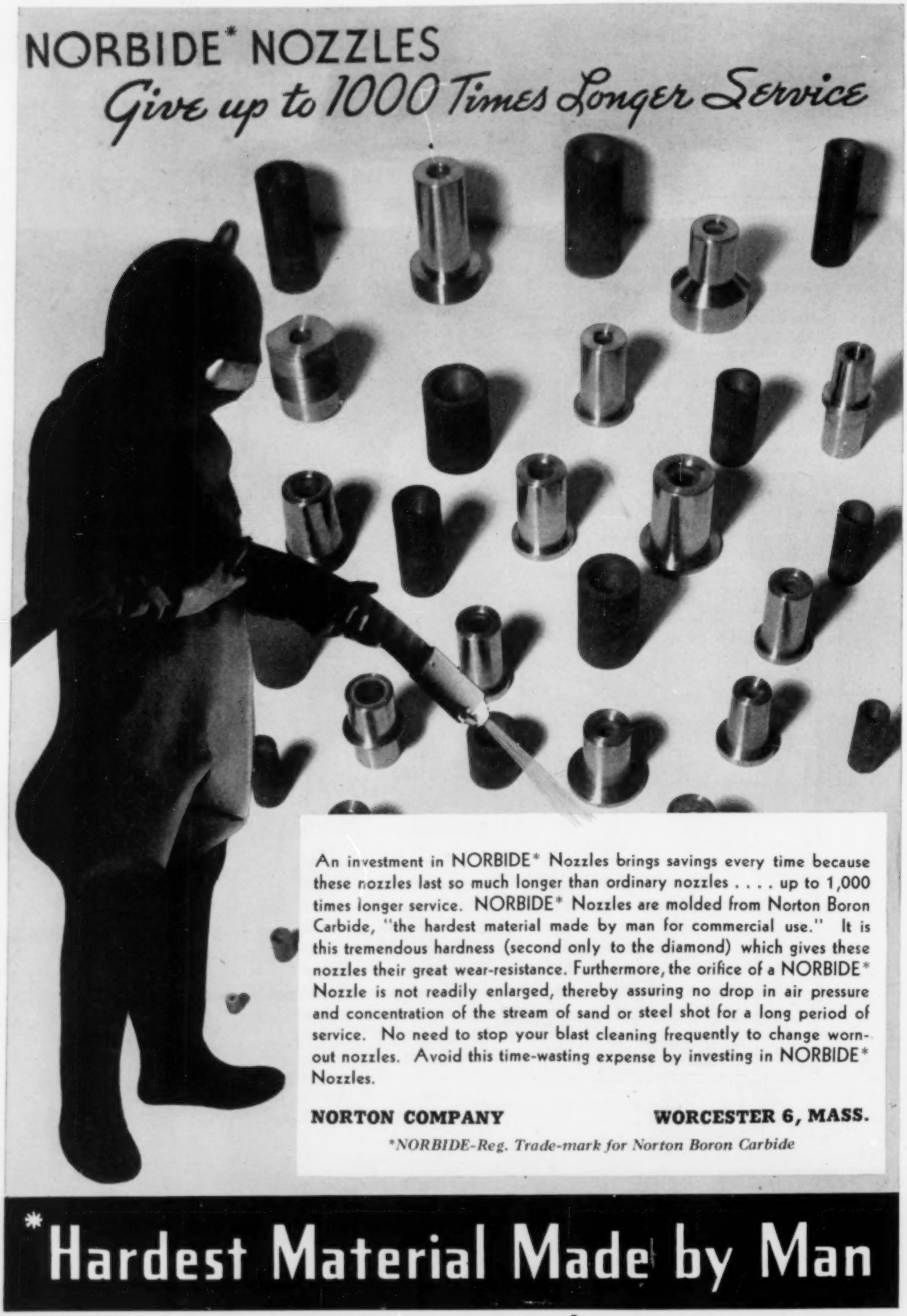

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# Compressed Air Magazine

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### ON THE COVER

TWO 75,000-kw. generators and their associate 103,000-hp. turbines built for Shasta Dam have recently been moved there from Grand Coulee Dam, where they were temporarily installed to meet the wartime demand for electricity. The work necessitated removal of the 6500 cubic yards of concrete enclosing them. No explosives could be used, so the concrete was "quarried" largely by line drilling. Our cover picture shows M. C. Watson, Bureau of Reclamation employee, standing beside a sizable block loaded on a car for disposal. Some pieces weighed as much as 90 tons.

●

### IN THIS ISSUE

OUR leading article is another chapter in the story of how the Bureau of Reclamation is bringing water through the Continental Divide in Colorado to eastern-slope farmlands to provide them with adequate irrigation.

●

HOW huge generators were freed from their concrete encasements without disturbing others operating nearby is told in *Concrete Surgery at Grand Coulee* (page 331).

●

A NEW semiportable compressor assembly that reduces wastage of natural gas produced with petroleum is described in the article starting on page 321.

●

INTERESTING facts concerning Canada's wartime Shipshaw hydroelectric development is presented in another of W. M. Goodwin's articles on our northern neighbor's waterpower resources.

●

### CORRECTION

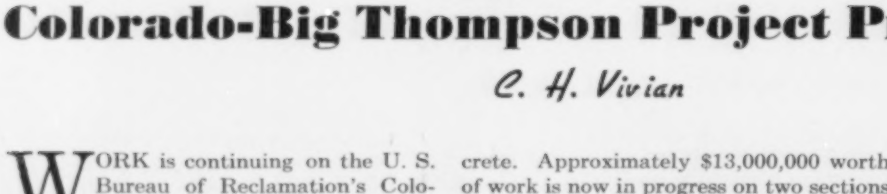
A CAPTURED Japanese air compressor that was displayed at Fort Belvoir, Va., by the Engineer Board of the Army Service Forces was described on page 249 of our September issue as having a capacity of 3000 cfm. at 300 pounds discharge pressure. This capacity was attributed to it erroneously by the Army authorities because of incomplete information at the time the exhibit was arranged. The correct rating is 3000 cubic feet per hour (50 cfm.) at 3000 pounds discharge pressure.

# Colorado-Big Thompson Project Progresses

C. H. Vivian

WORK is continuing on the U. S. Bureau of Reclamation's Colorado-Big Thompson Project in Colorado that will divert water from the western side of the Continental Divide to provide additional irrigation for 615,000 acres of rich farmland now under cultivation on the plains east of the range. The key structure in the scheme is the 13.06-mile Alva B. Adams Tunnel that will carry 550 second-feet of water through the divide. It was holed through in June, 1944, and has since then been lined with concrete. Approximately $13,000,000 worth of work is now in progress on two sections of the chain of structures through which the water will pass on its way from the tunnel outlet to the area where it will be used. Other units will be built when appropriations become available. Conduits, tunnels, powerhouses, storage reservoirs, and canals are embraced in the eastern-slope system.

When the project is in operation, it will deliver each year 310,000 acre-feet of water to more than 960 square miles of



PART OF GENERAL PLAN OF SCHEME

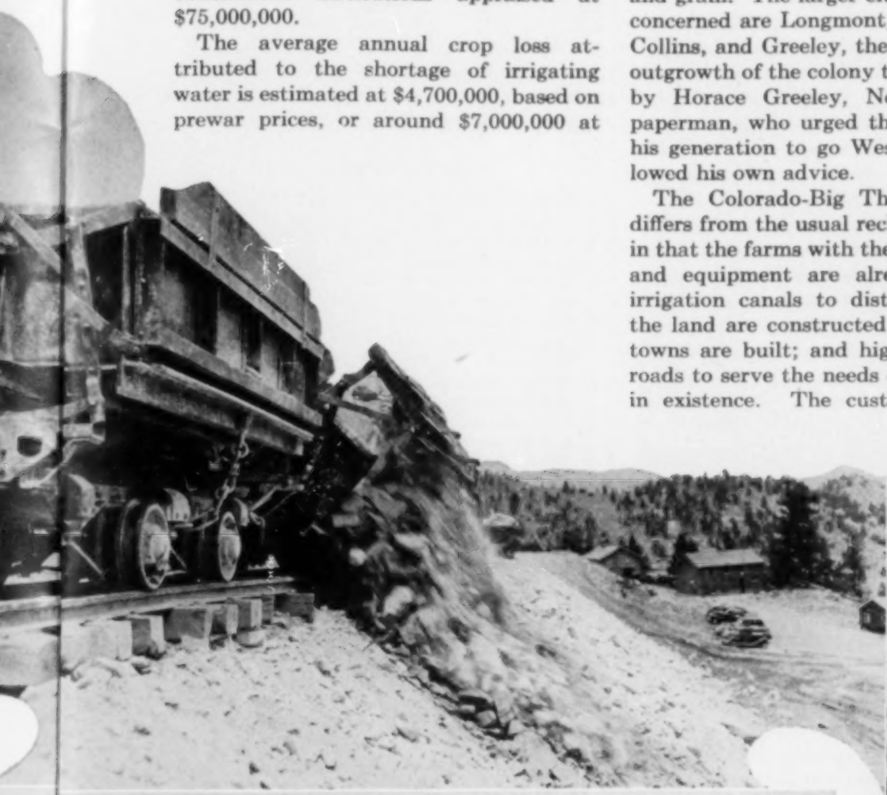
Water impounded by Granby Dam, on the headwaters of the Colorado River, will be pumped into Shadow Mountain Reservoir, which will serve to extend the area of Grand Lake, a natural body of water. From Grand Lake it will flow at the rate of 550 second-feet through the Continental Divide by way of the Alva B. Adams Tunnel, and thence by aqueduct to Estes Park. Eventually, more aqueducts will carry the water down to the plains, and there will be several power plants in the line, but for the present it will flow down the Big Thompson River. Where the latter emerges from the foothills, the water will be diverted into storage reservoirs, one of which, Horsetooth, is shown.

agricultural land that is now inadequately irrigated. Within the territory affected there are 175,000 people who live directly or indirectly by farming. The area has a taxable property value, including equipment and livestock, of nearly $210,000,000. In addition, there are nontaxable irrigation systems and religious and educational institutions appraised at $75,000,000.

The average annual crop loss attributed to the shortage of irrigating water is estimated at $4,700,000, based on prewar prices, or around $7,000,000 at present prices. One of the principal products is sugar beets, which makes the undertaking of current interest to every American household. Further interest arises from the fact that the pulp that remains after the sugar has been extracted from the beets is an excellent feed for livestock. Other leading crops are alfalfa and grain. The larger cities in the region concerned are Longmont, Loveland, Fort Collins, and Greeley, the latter being the outgrowth of the colony that was founded by Horace Greeley, New York newspaperman, who urged the young men of his generation to go West, and then followed his own advice.

The Colorado-Big Thompson Project differs from the usual reclamation scheme in that the farms with their houses, barns, and equipment are already there; the irrigation canals to distribute water to the land are constructed and in use; the towns are built; and highways and railroads to serve the needs of commerce are in existence. The customary wait for settlers to move in and start producing does not figure in this case. The supplemental water will insure full crops, whereas under present conditions a considerable acreage cannot be planted in years when precipitation on the eastern slope of the range is subnormal. It will also insure the maturing of late crops, which now often go without water in the autumn because the available supply has been used up during the summer months.

As is the rule with projects sponsored by the Bureau of Reclamation, the consumers will pay their share of the cost of providing the water. Through their organization, the Northern Colorado Water Conservancy District, they have contracted to repay $25,000,000 of the construction bill. This will be spread over a 40-year period, and it is estimated that it will amount to $2 per acre-foot of water used per year. Thus a farmer who puts 12 inches of the water on 80 acres of land in a season will owe $160. The balance of the cost—approximately $71,000,-



GENERAL VIEWS

In the foreground of the picture at the top of the preceding page is Mary's Lake, where a hydroelectric station will be built. Beyond it is Prospect Mountain, which will be pierced by a tunnel to carry water on toward Estes Park. Shortly before it reaches Mary's Lake the water will pass through Rams Horn Tunnel, now being driven. A drilling crew is shown above about to go on shift, and at the top-center a car of muck is being dumped. Some 25 miles eastward and half a mile lower, at the base of the mountain range, the water will be stored for distribution to now inadequately watered farmlands. At the left is the site of Horsetooth Reservoir, where $10,000,000 of construction work is in progress. The stone building in the center, recently a farmhouse, is used as a Government office. The view was taken looking toward the North.

**RAMS HORN MOUNTAIN**

A view looking south across Mary's Lake, showing the mountain as it appeared before the current program of work was started. The circle indicates the approximate location of the outlet of the tunnel. From the latter, the water will drop 212 feet through a 96-inch penstock to a power plant that will be situated on the opposite shore of the lake. Rams Horn was formerly known as Giant Track Mountain.

**PERSONNEL**

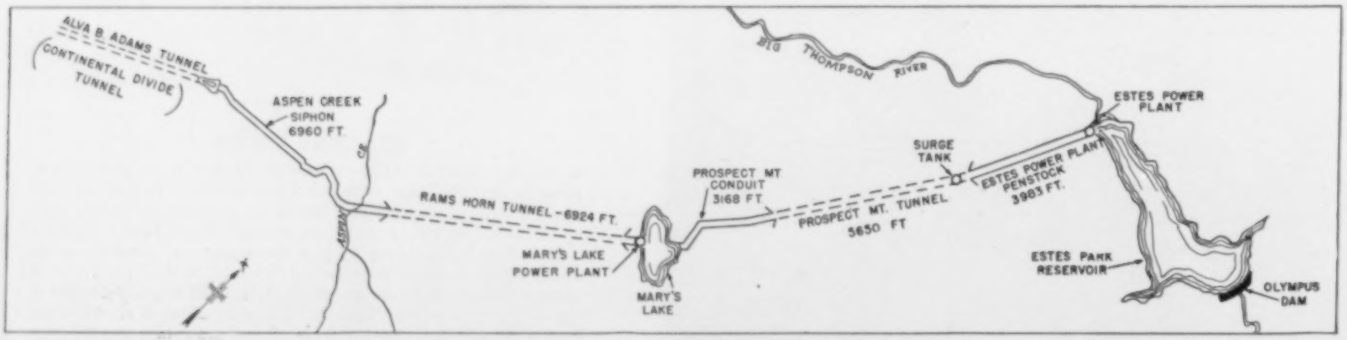
Supt. George W. Foster (left) who is in charge of the Rams Horn and Prospect Mountain tunnel jobs for Lowdermilk Bros., and Robert Harles, master mechanic. Although still a young man, Mr. Foster is an experienced tunnel driver. He started as a hard-rock miner in Canada and later shifted to construction work. In chronological order, he served during the past ten years as superintendent of the following operations: 3 miles of Delaware Aqueduct tunnel under the Hudson River, New York, from Shaft 6 for Pleasantville Constructors; 3-mile hydroelectric tunnel at Glenville, N. C., for Morrison-Knudsen Company, Inc.; 8½ miles of waterpower tunnels on the Apalachia Project of the Tennessee Valley Authority; underground fuel-storage facilities at Red Hill, Hawaii, for the U. S. Navy while a member of the armed forces. Following his discharge from the Navy, he was engaged for a time as shift superintendent on the Brooklyn-Battery Vehicular Tunnel, New York City, and then took over his present duties.

000—will be assumed by the Government and be chargeable to power development.

Eventually, the generating capacity will total 175,500 kw., but the full equipment will not be installed until a market for the power is in sight. For the time being, some of the hydroelectric works will not be built, which means that all of the $71,000,000 allocated to this phase of the project will not be spent immediately. About 50 cents per acre-foot of the annual construction charge, together with the operating costs chargeable to the conservancy district, will be collected by a tax of one mill on the property in that district.

From the eastern end of the Alva B. Adams Tunnel, at Elevation 8261, the water brought through the divide will be led to the Big Thompson River, at a point just east of the town of Estes Park near the eastern boundary of Rocky Mountain National Park. En route, it will drop 782 feet, and advantage will be taken of this to generate power at two sites. Between Estes Park and the plains, 25 miles eastward, there is a further drop of some 2000 feet, and the ultimate plan calls for five power plants in that stretch. For the present, however, the water will flow down the Big Thompson and then, where the stream emerges from the mountains, it will be diverted into storage reservoirs that will feed the network of irrigation canals leading to the farmlands.

During the first stage of its travel downward from the tunnel, the water will pass through 6960 feet of concrete pipe having an internal diameter of 10 feet 9 inches and a maximum wall thickness of 13 inches. This conduit, which is designated as the Aspen Creek Siphon, will deliver the water to the upper end of the Rams Horn Tunnel, which will be 6924 feet long


ALVA B. ADAMS TUNNEL
(CONTINENTAL DIVIDE TUNNEL)
ASPEN CREEK SIPHON 6960 FT.
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ASPEN
RAMS HORN TUNNEL - 6924 FT.
MARY'S LAKE POWER PLANT
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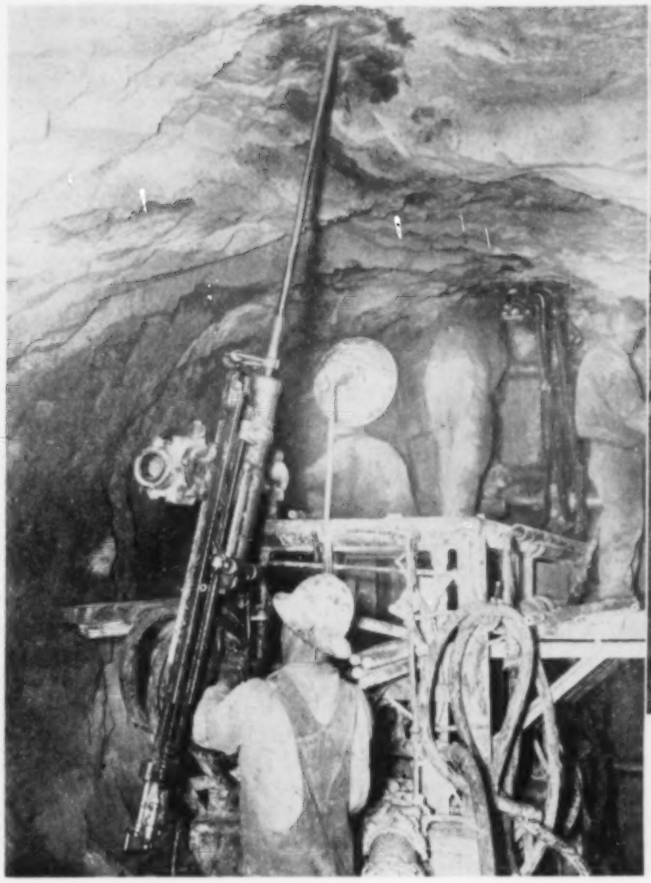
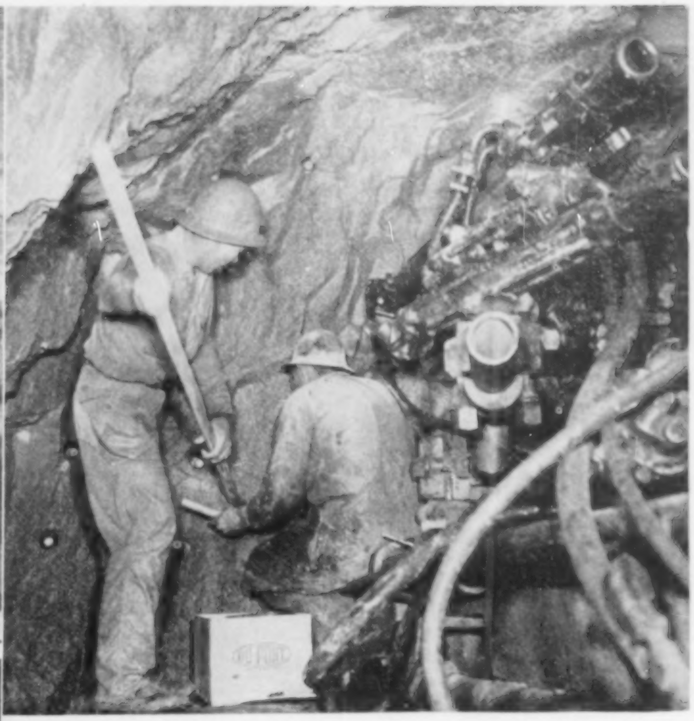
SURGE TANK
ESTES POWER PLANT PENSTOCK 3983 FT.
BIG THOMPSON RIVER
ESTES POWER PLANT
ESTES PARK RESERVOIR
OLYMPUS DAM
N

**LINE OF AQUEDUCT IN ESTES PARK AREA**

Through the chain of structures indicated here, the water diverted from the western slope by the Alva B. Adams Tunnel will flow a little more than 5 miles to Estes Park Reservoir. It will drop approximately 780 feet, and more than 700 feet of this potential head will be utilized to generate power at two points. Rams Horn and Prospect Mountain tunnels are now being driven, and the steel penstocks for the hydroelectric plants have been contracted for. From Estes Park Reservoir the water will be carried some 25 miles to the plains by the Big Thompson River.





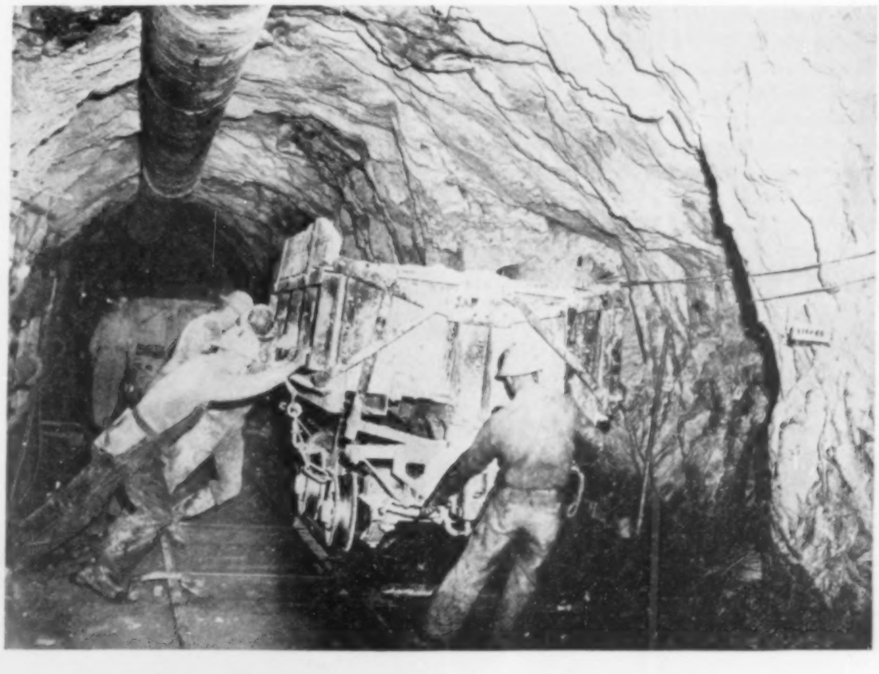
AT THE TUNNEL HEADING

Two views in Rams Horn Tunnel. The drill carriage has five DA-35 drifters in front and one at the rear for putting in overhead holes, as shown at the left. Two members of the crew are pictured above loading holes with dynamite even before the drill carriage has been moved back.

and 10 feet in diameter with its concrete lining in place. It will be nearly level, with a difference in elevation of but 7½ feet between portals.

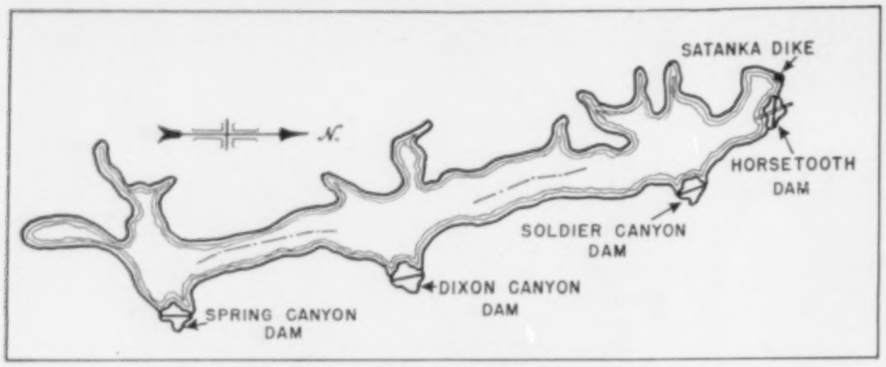
From the Rams Horn the water will fall 212 feet through a 521-foot-long, 96-inch-diameter penstock to an 8100-kw. turbine-generator, and from the powerhouse will discharge into Mary's Lake, a small natural body of water where two dikes will be built to raise the high-water level 20 feet. From the lake, at Elevation 8035, the water will flow through 3144 feet of concrete conduit of 12½-foot section. This will pass it into Prospect Mountain Tunnel, a 5650-foot, concrete-lined bore with a finished diameter of 12½ feet. From the tunnel it will enter three steel penstocks, each 78 inches in diameter, which will extend 3983 feet to the Estes Power Plant on the south bank of the Big Thompson. This station will house three generating units, each of which will have a capacity of 15,000-kw. and will operate under a net head of 510 feet. The tailrace will be at Elevation 7479.

From the power plant the water will enter Estes Park Reservoir, which will be formed by rearing Olympus Dam a short distance downstream. The dam will be 1000 feet long and 50 feet high, but the type of construction has not been determined. The reservoir will have an active storage capacity of only 1600 acre-feet and will release water into the river to flow down to the diversion works that will direct it into canals extending to other storage basins. The Bureau of Reclamation has established offices and houses adjacent to the site of Estes Park Reservoir for the engineers who are concerned with the works just mentioned. Considerable gravel has been taken from the reservoir area and processed for the



SWITCHING MUCK CAR IN RAMS HORN TUNNEL

Short lengths of rails, which fit on top of the regular rails, are mounted on small wheels that travel on transverse rails. The car has been run to this section and is being pushed off to the side of the main track. When the muck train has passed, the empty will be moved back on the main track to become the head car of the train and the next to be loaded at the heading.



HORSETOOTH RESERVOIR

This basin is being made by erecting four earth-fill dams and Satanka Dike at the locations shown. When full, it will have an area of 1873 acres and will store 147,322 acre-feet of water. The principal outlet works will be in Horsetooth Dam, at the northern end. To enable water to flow to them when the reservoir is at low level, channels, indicated by broken lines, will be excavated through high areas in the reservoir bottom.

concrete that will be required in building the various structures.

A contract for driving and lining the two tunnels was let on March 21, 1946, to Lowdermilk Bros. of Denver, Colo., on a low bid of $1,864,822. The contractor started drilling the Rams Horn on April 29. Some work also was done on Prospect Mountain Tunnel but was stopped after a few weeks by shortages of materials. It was then decided to complete excavating the Rams Horn before resuming operations on the other bore. While Prospect Mountain Tunnel is being driven, Rams Horn will be lined, with the concrete mixing plant stationed at its outlet end. The same plant will be moved later to the outlet portal of Prospect Mountain bore for service in lining it.

Because of its relatively short length, Rams Horn Tunnel was attacked from a single heading at its lower end. Before the contract for it was awarded, some preliminary work had been done there under negotiated prices by S. S. Magoffin Company, which had drilled 8 miles of the Alva B. Adams Tunnel. An access road and certain other facilities were therefore available for immediate use by Lowdermilk Bros.

Uniformly favorable granite rock that is practically devoid of seams and stands without supports was encountered as soon as the heading got into solid ground and has contributed to the steady progress that has been made. Another advantageous factor has been the absence of water, the bore being so dry that water for the drills and for wetting down the muck pile has to be piped in from outside.

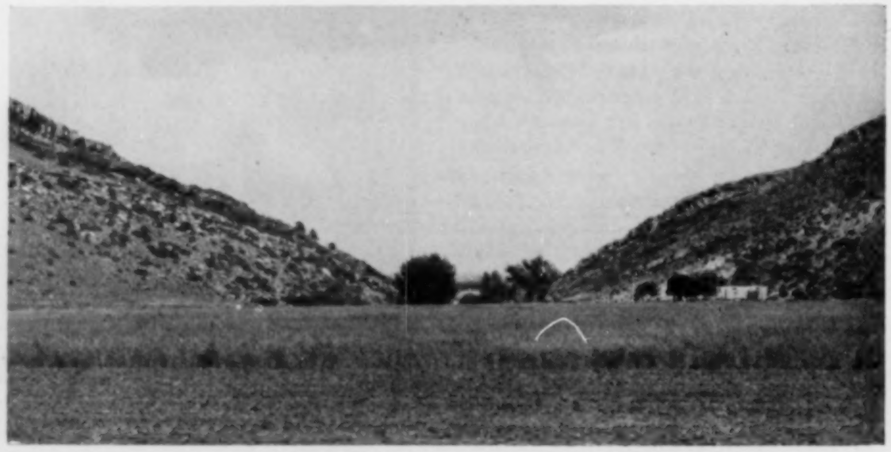
As excavated, the tunnel is of horseshoe-shaped section, 11½ feet in diameter. From 39 to 44 holes are drilled in a round, the number depending upon rock conditions. The maximum depth of the holes is 7 feet, and the average advance per round shot is 6½ feet. A conventional steel drill carriage mounted on railroad trucks is employed for the work. On its forward end are five Ingersoll-Rand DA-35 power-feed drifters equipped with drill-steel centralizers for ease in collaring holes. At the rear is a sixth drill of the same type for trimming and putting in overhead holes in which to secure supports for ventilation piping, lighting line, etc. The DA-35—a 154-pound, 3½-inch-cylinder-bore machine—has been used in driving all the notable Colorado tunnels in recent years, including the Carlton at Cripple Creek, the Alva B. Adams, and the Treasury near Ouray.

Detachable drill bits are utilized, and there is a 1/16-inch reduction in gauge with each bit change. New starter bits are 1⅞ inches in diameter, and holes are bottomed at a minimum diameter of 1¾ inches. Drill rods 3, 5, and 7 feet long are employed successively. Both bits and drill rods are trucked to Denver, some 65 miles away, for reconditioning in a custom shop.

Blasting is done electrically with du Pont 45 percent Gelex No. 2 powder and Atlas exploders. A Conway mucking machine, equipped with a ½-yard bucket and powered by a 60-hp. motor, loads the broken material into Western side-dump cars that have a rated capacity of 4 yards but are increased to 5 yards by the addition of side and end boards. Empty cars are transferred from the rear to the forward end of a train by a car passer, manufactured by the American Mine Door Company, that fulfills the same function as a "cherry picker."

To accommodate the unit, a chamber 3 feet deep and about twice the length of a car is excavated in one wall at a convenient distance from the heading. After a car has been loaded, the train is run back to the passer where the rear, empty car is shunted off to the side. The train is then backed until all cars have passed that point, after which the empty is again placed on the track but at the head of the train to be moved up to the heading for loading. The switcher is shown in an accompanying illustration. Trains are drawn by Atlas 8-ton electric-storage-battery locomotives, of which three are in service. The track, which is of 36-inch gauge and 60-pound rails laid on wooden ties, is heavier than that usually used in a small tunnel. It has proved of advantage in expediting haulage and promoting safety by minimizing derailments.

A complete cycle of operations, or excavating round, has normally been carried out in about 3 hours and 20 minutes. Immediately after a blast, the blower outside the bore, which ordinarily sends in fresh air, is reversed to exhaust the smoke and gases for fifteen minutes. Mucking follows and consumes about an hour. The remainder of the period—approximately two hours—is devoted to moving the drill carriage back to the face, setting up, and drilling. Under this schedule, an average of seven rounds is made daily, or an advance of around 42 feet, and this pace has been maintained during the greater part of the work. The footage driven by months has been: April, 53; May, 1045; June, 1070; July (working period cut to seventeen days by a strike), 737; August,



DIXON CANYON DAM SITE

The dam, at a completed height of 220 feet, will occupy approximately two-thirds of the broad V-shaped gap. The cliff shown on the skyline is the upper edge of the Dakota formation which will form abutments for the dam.

1137; September 1105; and October 1261.

Compressed air is supplied by an Ingersoll-Rand Type XCB compressor of 1120 cfm. capacity that is belt-driven by a 200-hp. motor. A smaller unit with a capacity of 365 cfm. also is available and supplies supplemental air during peak periods. The air leaves the units at 110 pounds pressure and is conveyed into the tunnel by a 6-inch line made up of 40-foot pipe lengths assembled with Victaulic couplings. A big air receiver interposed in the line at a point 4000 feet in from the portal insures air at constant pressure at the drills even when a large volume is suddenly drawn from the system. The air line and a small water line are carried along one side of the tunnel and about a foot above the invert. A 20-inch flanged ventilating pipe is suspended overhead, close to the roof.

Electric power comes in over Bureau of Reclamation lines at 2300 volts to a substation located within a quarter-mile of the job, and is stepped down to the various voltages required, the lowest of which is 110 volts for the blasting circuit. Water for cooling the compressors, for use in the tunnel, and for other general purposes is pumped from nearby Mary's Lake to two storage tanks on the mountain above the portal and flows from them to points of application by gravity. Drinking water is piped to the site from a spring.

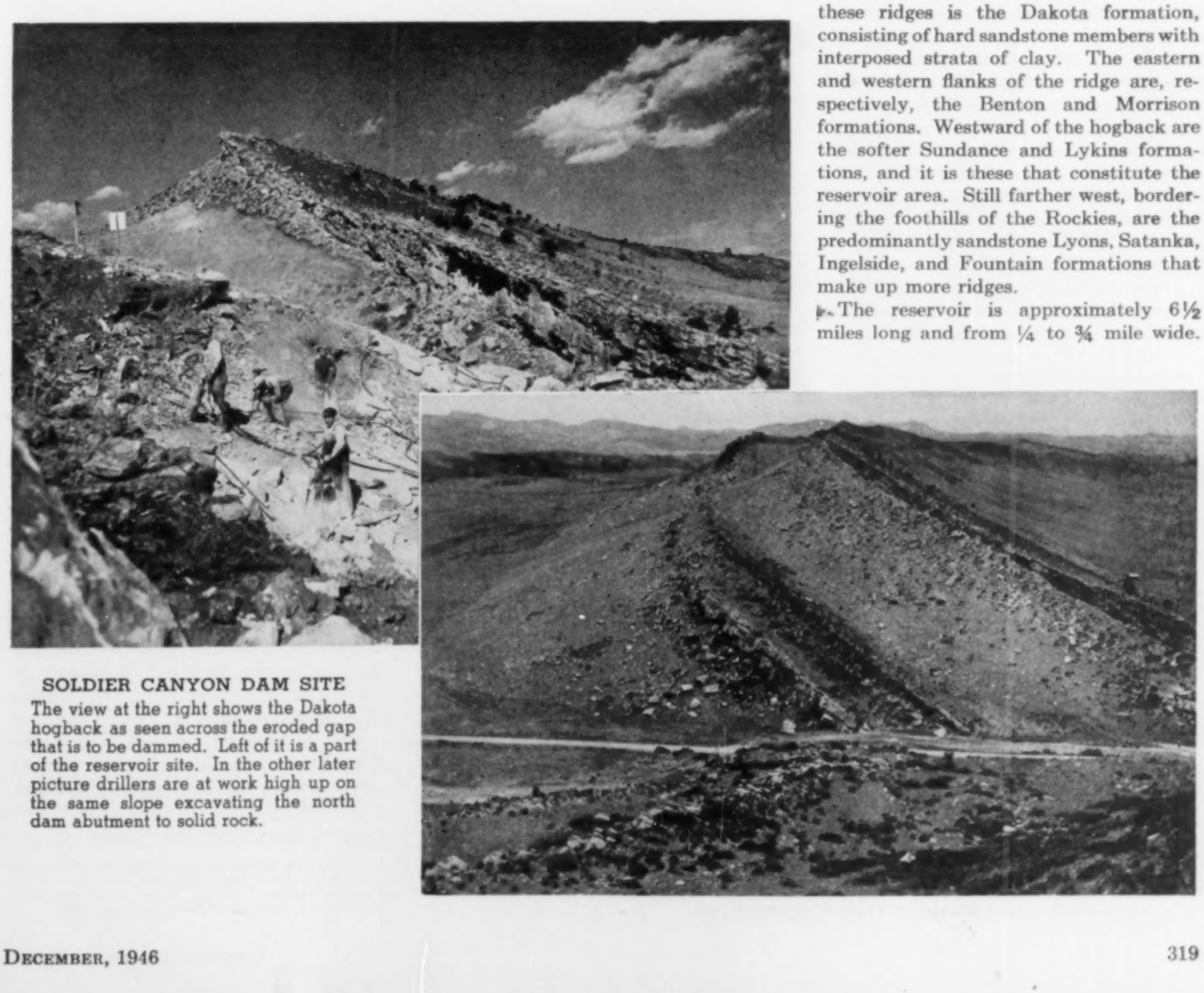
Prospect Mountain Tunnel, where operations were suspended after 544 feet had been driven, will be circular in section —14½ feet in diameter as excavated. The same equipment and procedure employed in the Rams Horn bore will be utilized on that job. In addition to tunneling, it involves the construction of a cylindrical surge chamber, 50 feet in diameter and 100 feet high, that will rise vertically through the rock to the surface of the mountain and at a point 206 feet in from the outlet portal. To carry out this work, a pilot raise, 7x11 feet, will be driven in the center of the section from the tunnel with the aid of two stoping drills. The remainder of the excavating will be done from the surface, with the central raise serving as a chute for muck removal. The latter will be equipped at its lower end with a gate for withdrawing the material into cars on the tunnel level. After 15 feet of the full section has been excavated, it will be lined with concrete in three 5-foot pours. The same procedure will then be repeated down to the tunnel line.

The contracting firm of Lowdermilk Bros. is made up of Hoyle, Zimmie, and Elbert Lowdermilk. Hoyle is the partner directly concerned with this work. In charge of the job under him as superintendent is George W. Foster. J. H. Johnson is office manager and engineer, Robert Harles is master mechanic, and A. M. Brown is chief electrician. Walking bosses are Jack Guthrie, Frank Archer, and Charles Phillips.

The principal storage facilities for regulating the delivery of the imported water to the canals that serve the farming areas will be Horsetooth Reservoir and Carter Lake. The former, which will supply the northern section of the district, is now under construction at the base of the mountains and 4 miles west of Fort Collins. The site is a dry, narrow valley paralleling the front range that was formed by geological action extending over millions of years. Eons ago, this was the shore of a great sea in which successive layers of sediments were deposited and afterward consolidated into rock. Then the mountain-making uplift tilted them to their present steeply dipping attitude. Thus the ends of the strata were exposed to the weathering agencies, and as some layers were softer than others they were eroded faster and valleys were formed in them. The more resistant rocks became ridges which, because of their contours, are locally known as "hogbacks."

The backbone of the easternmost of these ridges is the Dakota formation, consisting of hard sandstone members with interposed strata of clay. The eastern and western flanks of the ridge are, respectively, the Benton and Morrison formations. Westward of the hogback are the softer Sundance and Lykins formations, and it is these that constitute the reservoir area. Still farther west, bordering the foothills of the Rockies, are the predominantly sandstone Lyons, Satanka, Ingelside, and Fountain formations that make up more ridges.

The reservoir is approximately 6½ miles long and from ¼ to ¾ mile wide.



**SOLDIER CANYON DAM SITE**

The view at the right shows the Dakota hogback as seen across the eroded gap that is to be dammed. Left of it is a part of the reservoir site. In the other later picture drillers are at work high up on the same slope excavating the north dam abutment to solid rock.

**JACKHAMER MAN**

Close-up of a driller at the site of Soldier Canyon Dam.

STATISTICS OF HORSETOOTH RESERVOIR DAMS

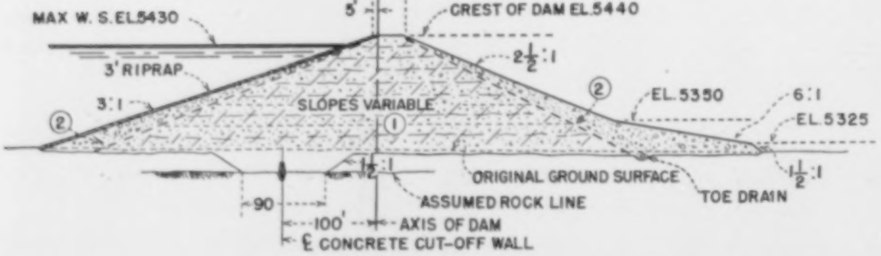
| Dam | Height Feet | Crest Length Feet | Impervious Fill Cubic Yards | Pervious Fill Cubic Yards |
|---|---|---|---|---|
| Horsetooth | 125 | 1600 | 1,450,000 | 405,000 |
| Soldier Canyon | 205 | 1400 | 2,450,000 | 822,000 |
| Dixon Canyon | 220 | 1200 | 2,000,000 | 1,000,000 |
| Spring Canyon | 205 | 1110 | 1,425,000 | 785,000 |

Although Nature did a pretty good job of excavating this basin, she also created some gaps that must be filled in before the depression will hold water. Channels have been eroded at three points in the Dakota hogback that forms the eastern rim, and these V-shaped notches will have to be closed with dams. The southern end of the valley slopes upward and is high enough to serve as a natural impounding embankment, but the northern end is open and will require damming. Operations at present underway embrace the construction of these barriers and of outlet works, as well as of other incidental features.

At the northern end of the valley there is now at work under a $5,111,877 contract a group of firms composed of Grafe-Callahan Construction Company, Gunther & Shirley Company, both Nebraska concerns, and W. K. McIlyar of Dallas, Tex. It will build Horsetooth Dam and Satanka Dike to close the northern end of the reservoir, and will rear Soldier Canyon Dam, the most northerly of the three barriers required to seal the openings in the Dakota ridge. The two other Dakota dams—Dixon Canyon near the center, and Spring Canyon towards the southern end—are being built by Hinman Brothers Construction Company, a Colorado firm, and Rhoades Brothers & Shofner, of Los Angeles, Calif. Their contract is for $4,319,427.

The four dams will be earth-fill structures ranging from 125 to 220 feet in height and from 1110 to 1600 feet in crest length. All will be of zoned construction, with the materials in each of the several sections selected to perform a specific function. According to their locations in the dams, the requisites of these materials are watertightness, stability, and protection from erosion, percolation, or reservoir operation. Approximately 70 percent of the reservoir bed will overly the Lykins formation, which is composed of impervious red shales. Weathering, however, has covered the latter with from 3 to 20 feet of sandy loam overburden, and nearly all of this will be removed and transported to the dam sites for use in construction. Dimensions of the barriers and the quantities of materials in each are given in an accompanying table.

All the dams will have a crest elevation of 5440 feet, and the high-water line will be 10 feet lower. When full, the reservoir will cover 1873 acres and store 147,322 acre-feet of water, of which about 137,000 acre-feet can be withdrawn for irrigation purposes. The principal outlet works will be in Horsetooth Dam and will have a discharge capacity of 2500 second-feet with the reservoir at full level. The outflow, however, will be limited to 1500 second-feet because that will be the capacity of the connecting canal. Provision will also be made for the release of up to 80 second-feet of water through Soldier Canyon Dam for irrigating land immediately east of the basin.



**MAXIMUM SECTION, HORSETOOTH DAM**

All the dams are to be of much the same type, with some variation in materials and their placement. In this structure the two materials designated by the encircled numbers are: 1, Impervious mixture of clay, sand, and gravel graduating in coarseness toward outer slopes and compacted in 6-inch layers; 2, pervious mixture of sand, gravel, and cobbles compacted in 12-inch layers.

At two points in the reservoir area there are saddles running east and west, and as these would prevent water from flowing to the outlet works after its level had been drawn down even with their crests it is planned to excavate channels through them. These will have respective lengths of 2200 and 4700 feet and maximum depths of 25 feet. An approach cut, 1200 feet long and with a maximum depth of 20 feet, will lead water to the outlet works in Horsetooth Dam at low reservoir level.

Satanka Dike will increase the height of a short saddle at the northern end of the basin. It will be 285 feet long, have a maximum height of 15 feet, and be built as a rolled-fill embankment. Its crest will be 4 feet lower than those of the four dams and will serve as a spillway in case the reservoir becomes overfilled through faulty operation of the supply system. But there is only a remote possibility that it will ever have to be brought into use for that purpose, and as the drainage area from which surface water can flow into the reservoir is but 10½ square miles in extent, it has been calculated that a flash flood equal to the greatest on record would not raise the water elevation more than 1 foot.

It is estimated that the total cost of Horsetooth Reservoir will be approximately $11,000,000. This represents an outlay of $80 per acre-foot of storage capacity which, though high, is considered justifiable.

Plans and specifications for the operations described were prepared in the Denver office of the Bureau of Reclamation under the direction of Walker R. Young, chief engineer. C. H. Howell, with headquarters in Estes Park, is project engineer for the work in that area. Franklin K. Matejka is construction engineer, and Paul H. VanHorn field engineer. Richard B. Ward is construction engineer for Horsetooth Reservoir.

Editor's note: Previous articles on the Colorado-Big Thompson Project and the Alva B. Adams Tunnel appeared in the issues of March 1938, March 1941, November 1943, and July 1944.

Ewing Galloway Photo

**FLARE GAS**

Millions of cubic feet of natural gas that is produced with petroleum is burned daily in the oil fields because it cannot be saved economically. Much of this wastage may be avoided through the use of "packaged" semi-portable compressor plants such as are described in this article. They cost less than permanent installations and have advantages over the latter for certain kinds of work.

# Reducing Natural-Gas Wastage

### E. F. Neild, Jr. and D. T. Whiting

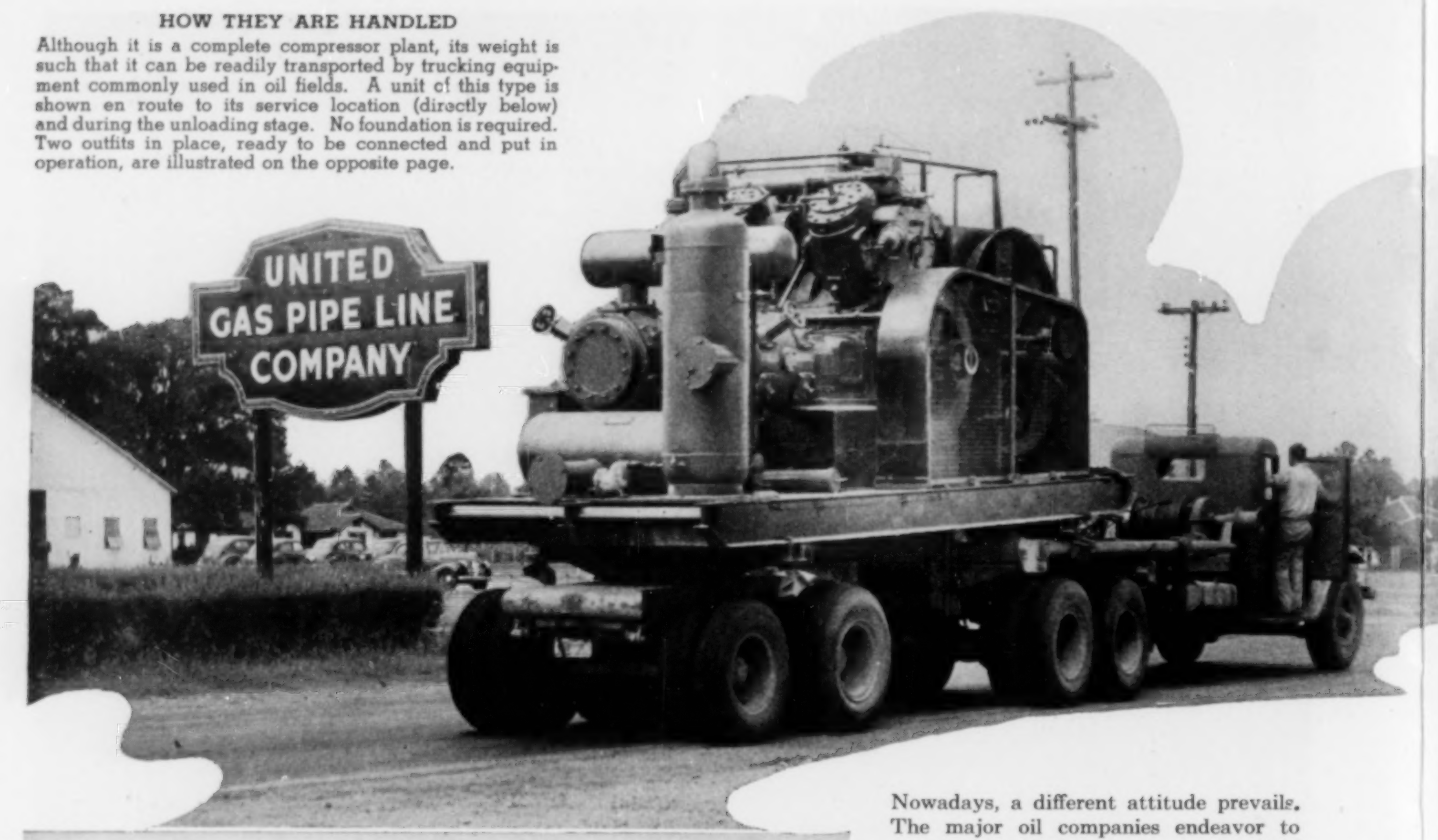
NATURAL gas plays two important roles in our national economy. Its virtues as a fuel are such that it is piped hundreds of miles to industrial and population centers in the midwestern and eastern areas. Texas gas is now being delivered as far east as Pittsburgh and, as this is being written, the War Assets Administration has under consideration sixteen bids to purchase the "Big Inch" and "Little Inch" pipe lines that were built to carry crude oil and its refined products to the Atlantic seaboard during the war period. Most of the bidders want to use the facilities to transport natural gas to the New York City area, and they may be put to that service, although the Government's first stand was that they could not be sold for any purpose other than the transportation of petroleum and its products.

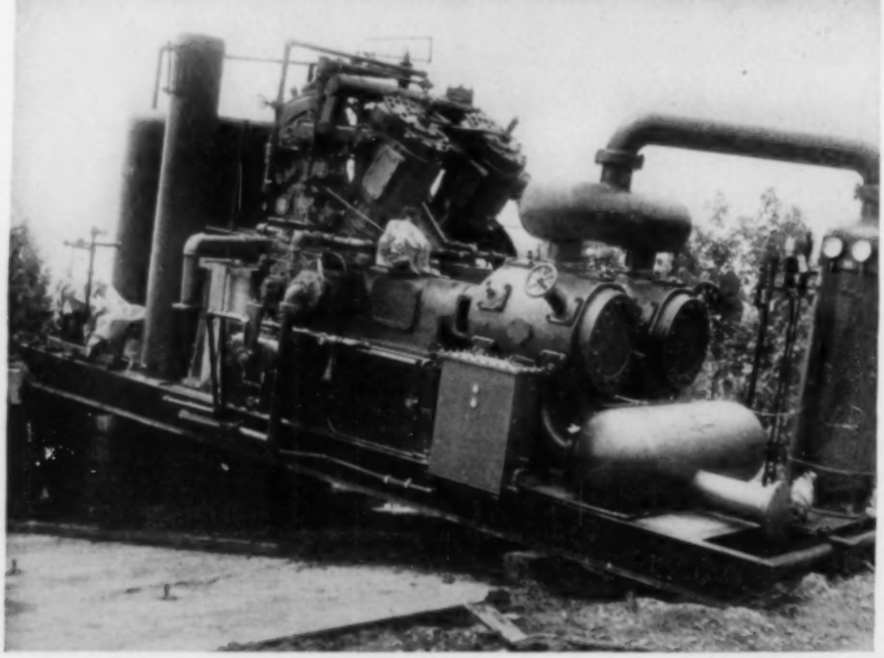
Sales of natural gas for fuel total around a billion dollars annually and must yield sizable profits. Nevertheless, the oil industry probably reaps a comparable net monetary gain from natural gas when the latter acts in its second and lesser-known role of lifting medium to bring petroleum to the surface of the ground. The typical subterranean oil reservoir contains petroleum as well as gas, most of which is dissolved in the former because of the great pressure exerted on the enclosing stratum by the overlying rocks.

When a well taps the reservoir, the expansive force of the gas lifts the oil and it shoots upward in the form of a gusher. Actually, there are in the column of oil myriads of gas bubbles that lighten and lift it in a manner similar to the action of an unruly charged-beverage bottle when the cap is removed. If the bottle is left uncapped, however, all the gas soon escapes, the liquid goes "flat" and no longer rises or even froths or foams. The same thing is true of an oil reservoir in the ground. Since the oil and gas are distributed throughout a porous rock structure it takes considerable time for the gas to be dissipated, but as additional avenues of escape are provided by the drilling of more wells, the gas will, if

### HOW THEY ARE HANDLED

Although it is a complete compressor plant, its weight is such that it can be readily transported by trucking equipment commonly used in oil fields. A unit of this type is shown en route to its service location (directly below) and during the unloading stage. No foundation is required. Two outfits in place, ready to be connected and put in operation, are illustrated on the opposite page.



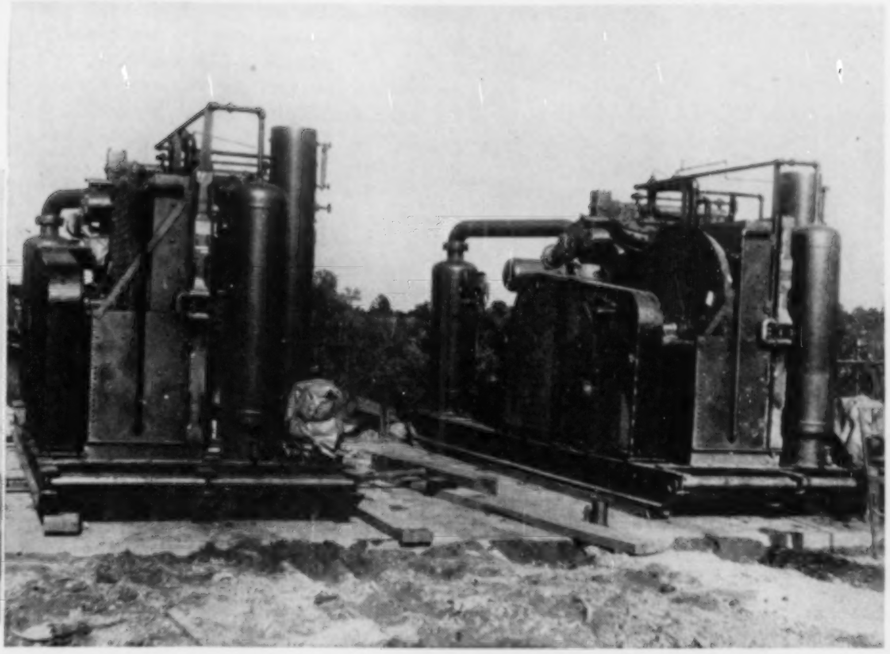


unrestrained, eventually issue from the ground. As more gas is lost, the natural flow of the wells decreases and there comes a time when there is insufficient pressure to force the oil to the surface. Under such conditions, artificial flowing methods such as by air or gas lift or pumping must be resorted to. This not only increases the cost of production but, it is generally agreed, also results ultimately in a lower over-all recovery of oil than if the gas pressure had been conserved.

In the early days of the oil industry the importance of the gas was either not understood or ignored. Wells were allowed to flow uncurbed, and so many were drilled that in some areas the derricks almost touched one another. The aim of each producer was to get all the oil he could as quickly as possible, lest the other fellow beat him to it. There was no regard for or concern about the future. Nowadays, a different attitude prevails. The major oil companies endeavor to open up new fields so as to prolong their production periods to the utmost. And in the interest of the public, states where oil is found have conservation commissions that exercise strict control over field development and output.

Where the land is divided into relatively small tracts, with diversified ownership, interests are pooled or unitized to form larger parcels, and everyone having acreage within their confines shares in the oil from wells drilled therein. This makes it practicable to put down wells in a definite pattern that insures adequate spacing. In fields where wells still flow by natural pressure, the daily output of each is limited to conserve the gas. Where conditions are favorable, the gas that is produced with the oil is run through a natural-gasoline plant to extract its liquid hydrocarbons, and the residue gas may then be put into a commercial pipe line for delivery to customers. In some instances, the gas that accompanies the oil is recompressed and forced back into the ground to maintain the pressure. In others, fields that have lost a considerable part of their original pressure are given a restorative treatment by compressing gas or air from another source and sending it underground.

But oftentimes such measures are not practical or feasible from a monetary standpoint, and in many fields there is inevitably some gas wastage. Upon reaching the surface, the oil with the entrained gas is piped to a separator where, with the pressure released, the gas dis-



sociates itself. The oil is run into storage tanks or pipe lines, while the gas, unless it can be economically handled, is burned. Those who have traveled through the oil country at night have viewed the spectacular gas flares with apprehension, and they are not exactly pleasing sights even to the producers who are continually seeking ways to cut down gas wastage.

In the foregoing case, however, the gas comes from the oil separator at very low pressure. There may be a gas-delivery main somewhere nearby, but in order to salvage the gas from the well it must be compressed to a pressure that will permit it to enter the main itself or the suction line of a permanent compressor station that serves the main. In numerous instances this is not practicable because even a small, permanent booster-compressor installation to compress say a million cubic feet of gas a day from atmospheric pressure to 20 or 30 pounds discharge pressure would probably involve an investment that the value of the gas reclaimed would not warrant.

There is every reason to believe that, as time goes on, the conservation bodies of the several states will progressively tighten their restrictions on gas wastage and that the oil industry will be compelled to find means of putting the gas that is produced with oil into commercial pipe lines so that it can be used. Any scheme that will salvage the millions of cubic feet of gas now being burned will have the same effect as the opening up of new gas wells to produce an equal volume and will obviate the necessity of drilling such wells. Thus, from an overall industry standpoint, the expenditures required for adequate conservation measures will be offset to some extent at least.

Some time ago, the J. B. Beaird Company, Inc., of Shreveport, La., made a survey of the flare-gas problem. Its interest in the matter was natural, since it builds equipment for the oil industry, including pressure vessels, heat exchangers, derricks, and other items. Studies revealed that, under current unitizing and spacing regulations, wells are generally an eighth of a mile or more apart and that the volume of flare gas at each well is comparatively small. A large centrally located compressor plant for handling the gas would, consequently, necessitate pipe lines of large diameter in order to draw into the plant a volume of gas at low pressure, or perhaps even under a vacuum, that would load it to capacity. Since the wells would most likely be scattered over an area of several square miles, the cost for suction piping alone might be prohibitive, to say nothing of the large investment that a permanent compressor station would entail. It was found that the average large permanent compressor plant involves an outlay of around $170 per horsepower installed, exclusive of the gathering lines. As the total investment would have to be amortized during the life of the field, it is evident that the expected duration of production would have to enter into the cost calculations. The conclusion reached was that such a scheme for handling the gas would frequently prove to be economically unsound.

Consideration was then given to breaking down the compressor plant into several smaller permanent units located in various parts of the producing area. It was apparent that this would greatly reduce the length of the expensive gathering-line system, but it was computed that the cost of the multiple compressor stations would be higher than that of one central plant. This was so largely because each would require a concrete compressor foundation and also considerable associate equipment such as gas scrubbers, cooling-water systems, etc. And, as in the previous case, the investment would have to be returned during the producing life of the leases. It was obvious that the salvage value of the stations under either plan would be low, inasmuch as the foundations and, to a large extent, the piping and connections of the cooling system and some other accessories could not be re-used, while the compressors would have to be dismantled and removed piece by piece.

In view of the fact that conditions prohibited the use of permanent compressor plants, Beaird engineers began to mull over the possibilities of a portable unit that would meet service and cost requirements. Discussions with engineers and producing superintendents of the major gas companies having main offices in Shreveport showed that the idea was worthy of development and, after obtaining their suggestions, a preliminary design was made for a compressor assembly compact enough to be transported by an oil-field truck and yet having sufficient power and compression capacity to handle a large volume of flare gas. Checking of the plan showed that the proposed unit would be practical and that it could be readily fabricated in the ample Beaird shops.

The studies indicated that a gas-engine-driven compressor plant of about 150 hp., complete in every respect and mounted for truck transportation, would be needed for the purpose. After it had finished its work at one location, it could then be easily moved to another without losing any of the construction materials or labor that had been put into it originally. The conditions called for a slow-speed, heavy-duty type that would be relatively free from vibration. During the war years, the Beaird plant had in use nine Ingersoll-Rand V-type engines ranging from 150 to 370 hp., some operating hydraulic forging equipment and others mounted integrally with horizontal compression cylinders to form Type XVG direct-connected compressors. Being familiar with the latter machines, and having first-hand information as to their dependability and operating characteristics, the engineers specified them for the new assembly.

In addition to the compressor, the unit includes all accessories, namely: a radiator for cooling water, with a separate section for cooling crankcase oil; a gasoline-engine-driven compressor and receiver to supply starting air for the main engine; a bauxite-type lubricating-oil filter; gas scrubbers; and all necessary automatic or manual controls, gas-pressure gauges, safety valves, etc., all mounted on a firm base and not exceeding 8 feet in width.

When the company let it be known that it was undertaking the development of such a portable outfit the industry showed immediate interest, and an initial order for eight was received. While they were being built it was noted where improvements could be made, and these were incorporated in the next units. The same thing was true as additional lots were put through the plant, and gradually there evolved a universal skid frame that will take either single-stage, 2-stage, or 3-stage compressor-cylinder combinations. Thus, if a user purchases a single-stage machine and later desires to convert it into a 2-stage unit he can buy the correct compressor-cylinder combination, a gas cooling coil, second-stage intake scrubber, and the connecting piping. The necessary changes can be made in the field, and none of the original equipment is lost except the compressor cylinder or cylinders that will not meet the new requirements. Approximately 30 units have so far been constructed.

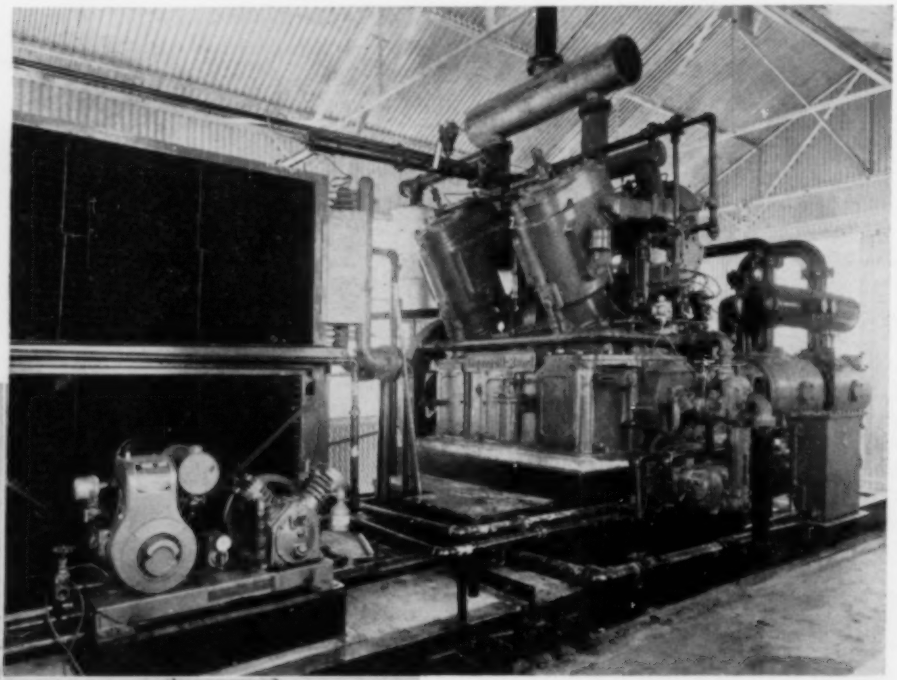
A typical application that has solved the flare-gas problem is found in Louisiana, where an oil company had been burning some gas produced with oil because its pressure was too low to cause it to enter any available natural-gasoline plant or commercial gas pipe line. Four of the portable single-stage compressor plants were utilized to take gas from the separators at around 1 pound gauge pressure and deliver it into a service pipe line at 25 pounds gauge pressure. These units are controlled by an automatic speed-and-pressure regulator on the governor of the engine so that they will slow down as the suction pressure drops, reaching their minimum speed when the suction pressure has been reduced to 1 pound. They are also equipped with a Mercoid shutdown switch to ground the magnetos if the suction pressure drops to ½ pound, this being a precautionary measure to prevent any air from getting into the commercial pipe line.

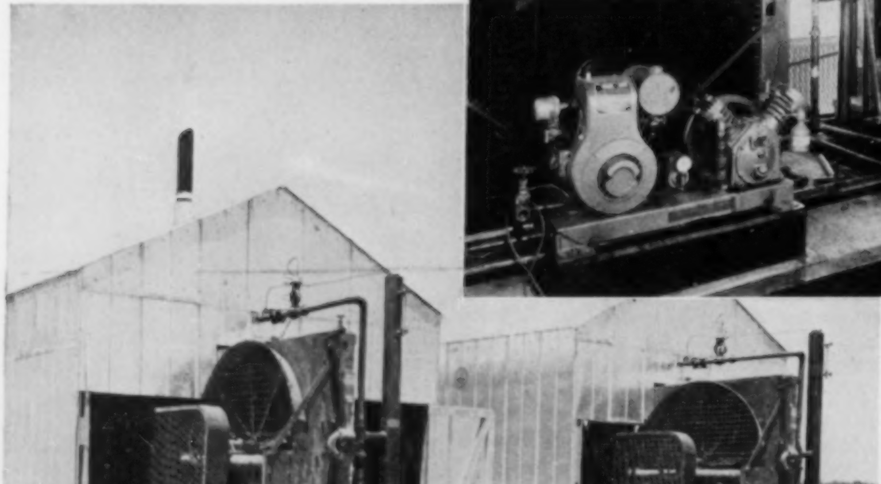
If the lease tender cuts off several wells and thereby reduces the volume of gas to be handled, the compressors will automatically slow down to meet this reduction. After a certain number of wells has been shut down, one of the machines will cease to operate, and as still more wells are closed in, a second compressor will stop, and so on until none is running. The units require no attendance other than a visit by a lease man once in twelve hours.

In addition to fulfilling the purpose for which it was designed, as just described, the outfit has been found suitable for various other services. For example, a Texas gas field originally had sufficient pressure to warrant building the main pipe-line compressor station to take suction at 150 pounds gauge pressure and boost it to 450 pounds gauge for delivery of the gas to its customers. As the field grew older, the pressure fell below 150 pounds, and the output of the plant was consequently lowered. Eight of the Beaird portable single-stage units have been placed in the field some 6 miles from the station and been divided into three widely separated groups. They take gas at field pressure, boost it to approximately 165 pounds gauge pressure, and deliver it to the main line compressor-plant suction, thereby restoring the station's capacity to that for which it was originally laid out.

The eight XVG field compressors have clearance pockets, valve lifters, and automatic speed-and-pressure controls whose functioning keeps the engines loaded with suction pressures ranging from 135 pounds gauge to 35 pounds gauge, with the discharge pressure remaining constant at 165 pounds gauge. The automatic speed-and-pressure governors permit the field units to float on the line. If the main compressor plant reduces or increases its delivery, the field machines automatically slow down or pick up speed correspondingly. Here again, the only attention they receive is a visit by a field man once every twelve hours.

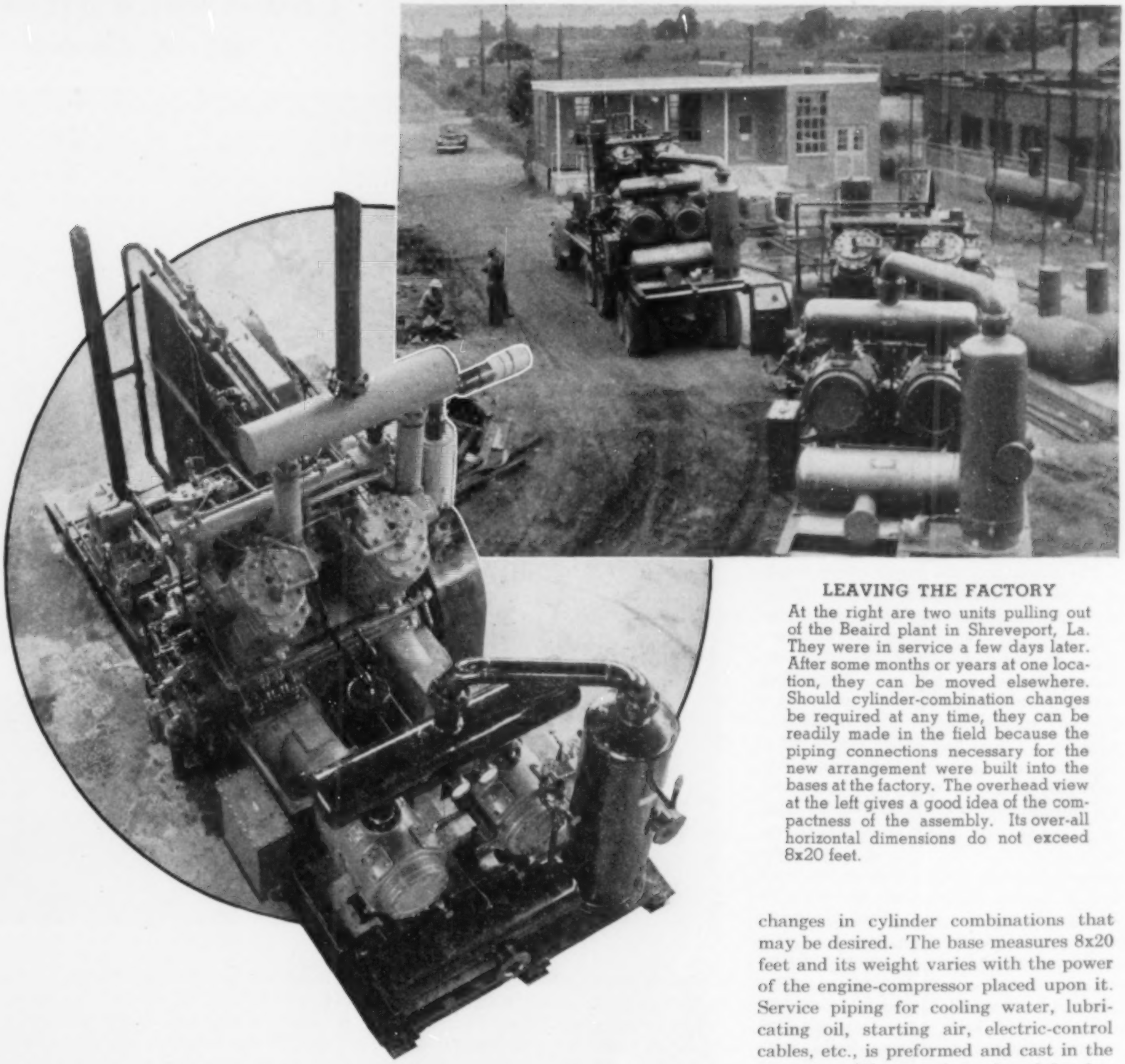
A carbon-black company in Louisiana is supplied with natural gas from wells that are twenty years old. The pipe line that carries it operates at 15 pounds gauge pressure, and some of the wells no longer have sufficient pressure to feed gas into the line. To overcome this situation, the





**UNDER COVER**

Oftentimes a compressor plant is set down on the ground and an inexpensive housing is then built around it. At the top is a 3-stage unit in service in West Texas. In the case of the outfits pictured at the left, the radiator ends were left outdoors to take advantage of the prevailing cooler air.



**LEAVING THE FACTORY**

At the right are two units pulling out of the Beaird plant in Shreveport, La. They were in service a few days later. After some months or years at one location, they can be moved elsewhere. Should cylinder-combination changes be required at any time, they can be readily made in the field because the piping connections necessary for the new arrangement were built into the bases at the factory. The overhead view at the left gives a good idea of the compactness of the assembly. Its over-all horizontal dimensions do not exceed 8x20 feet.

company will put one of the single-stage XVG units in the field and take suction on the weak wells at around 5 or 6 pounds gauge pressure and deliver the gas into the pipe line at 15 pounds pressure. This will make available to the carbon-black plant daily approximately five million cubic feet of gas that it could not obtain otherwise.

In west Texas an oil company has placed in service a 3-stage outfit that will compress gas from about 15 pounds gauge pressure to a maximum of 2000 pounds gauge. Over a period of months, this assembly is to be used to determine the pressure that will be required to return gas to the producing formation. The data thus procured will enable the engineers to design a permanent installation for gas injection.

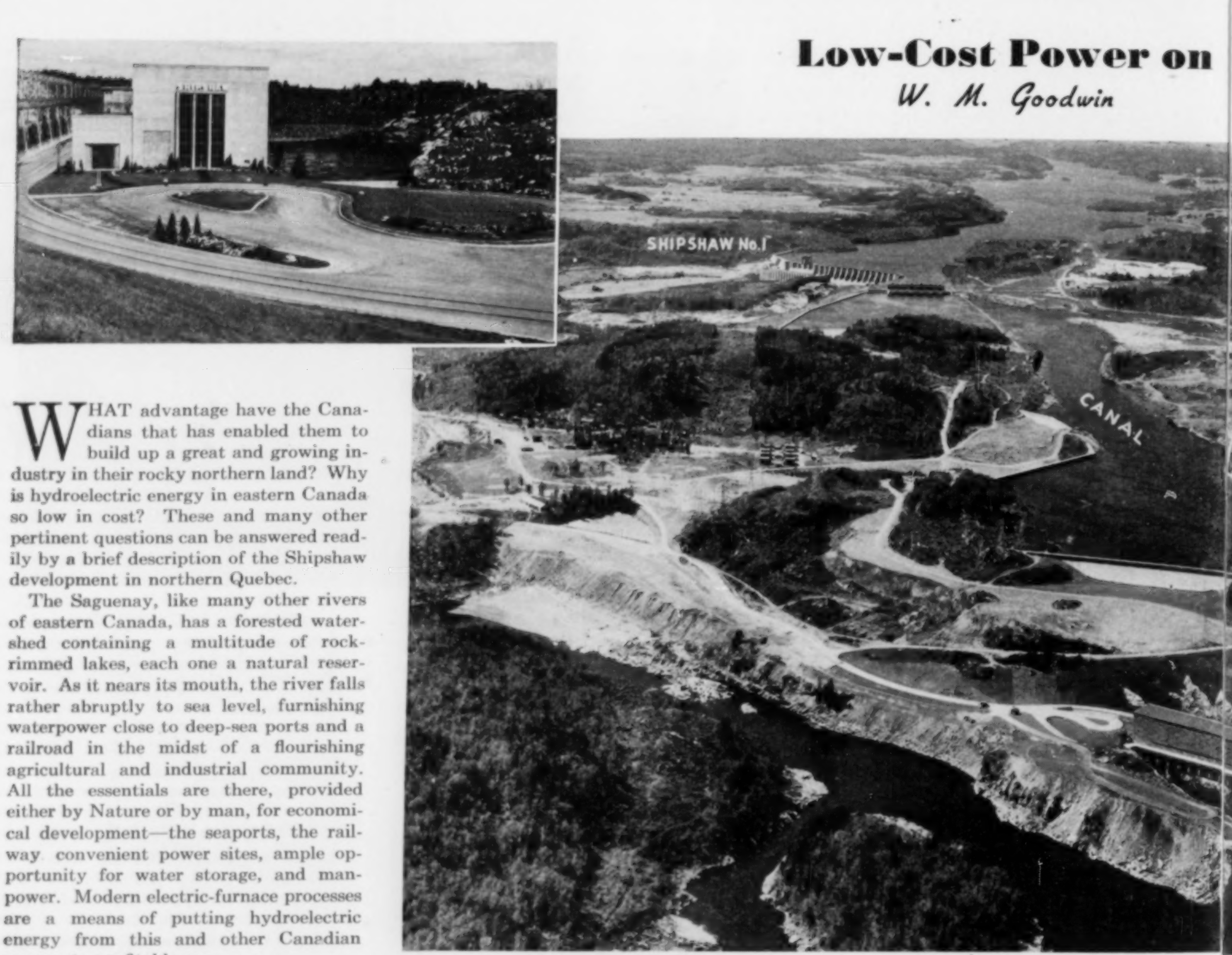
The portable units are also utilized to operate flow-valve equipment for the production of oil by gas lift. In this service, either residue gas from a natural-gasoline plant or waste gas from separators in the field can be brought to the compressor at low pressure. The operating pressure needed by the flow valves varies, but it is usually in the range of 500 to 600 pounds and calls for a 2-stage compressor. A single portable unit will generally serve several wells.

As at present designed, the superstructure of the assembly is built on a combination fabricated-steel-band-and-concrete base that incorporates the anchor bolts, depressions, piping, etc., necessary for mounting the component parts. A permanent steel mold is used in making this foundation so as to insure that all the components are located exactly where they should be to permit any future changes in cylinder combinations that may be desired. The base measures 8x20 feet and its weight varies with the power of the engine-compressor placed upon it. Service piping for cooling water, lubricating oil, starting air, electric-control cables, etc., is preformed and cast in the concrete. All exposed service piping between parts is compact and also preformed so that corresponding pieces on all units are interchangeable. Flexible couplings are provided wherever essential to relieve strains in the piping caused either by changes in temperature or by vibration.

Although varying somewhat in weight by reason of compressor details, none of the units exceeds the carrying capacity of the heavy haulage equipment customarily used in oil fields. And, upon being unloaded there, the outfit is ready for service, saving the customer the expense and trouble of providing engineering drawings for the foundation, buildings, piping, and incidentals needed in the case of a permanent installation. He gets a factory-made unit, produced under conditions that are more favorable than those sometimes encountered when erection has to be done in the field.

# Low-Cost Power on

*W. M. Goodwin*



WHAT advantage have the Canadians that has enabled them to build up a great and growing industry in their rocky northern land? Why is hydroelectric energy in eastern Canada so low in cost? These and many other pertinent questions can be answered readily by a brief description of the Shipshaw development in northern Quebec.

The Saguenay, like many other rivers of eastern Canada, has a forested watershed containing a multitude of rock-rimmed lakes, each one a natural reservoir. As it nears its mouth, the river falls rather abruptly to sea level, furnishing waterpower close to deep-sea ports and a railroad in the midst of a flourishing agricultural and industrial community. All the essentials are there, provided either by Nature or by man, for economical development—the seaports, the railway convenient power sites, ample opportunity for water storage, and manpower. Modern electric-furnace processes are a means of putting hydroelectric energy from this and other Canadian sources to profitable use.

While the Saguenay project was phenomenally rapid in its final stage, it was slow in beginning. Almost 50 years ago, "Carbide" Willson, fresh from his first great adventure at Niagara Falls, journeyed into the hinterland of Quebec to view the cataract whose power might multiply his success manifold and acquired the rights thereto. He had the vision, but not the vast capital required to back it up.

In 1912, Willson returned with J. B. Duke, who not only had both the prime requisites but also an unusually determined character. With them came Duke's engineer from North Carolina, W. S. Lee. Among them they roughed out the complete Saguenay plan, much as it is today. A dam at the Grand Décharge, where the river rushed out of Lake St. John, was to be built to take advantage of that great natural storage basin and at the same time utilize about one-third of the river's fall for power. Down near tidewater, at Chute a Caron, another barrier would permit using the remaining two-thirds of its energy. Storage dams on the streams feeding Lake St. John would still further conserve the spring run-off and bring the developed power near to the potential maximum.

This ambitious scheme could not be fulfilled at once, however, without courting disaster—it had to await its turn in the sequence of great electrometallurgical ventures that has marked the past half-century of Canadian industrial progress. The fixation of nitrogen was what Mr. Duke first had in mind. Later he changed over to aluminum. A large item of expense in the making of that metal is electricity. With power as low in cost as the Saguenay could provide, the price of aluminum might eventually be brought down to levels hardly thought possible at that time.

In 1923, Mr. Duke and his Canadian partner, Sir William Price, started work on the upper part of the Saguenay, at Ile Maligne. It took three years to complete the powerhouse (540,000 hp.) and the various dams required to control the flow from Lake St. John. But before the undertaking was finished they added a third man to their partnership, Davis—a pioneer name in the North American aluminum industry—whose company took over and was able to complete the financing of the whole vast enterprise.

In 1928 the lower dam at Chute a Caron was begun with the ultimate view of diverting the flow of the river into a canal, 10,000 feet long, to empty into the dredged gorge of the Shipshaw River at tidewater level. This is what gave the Shipshaw project its name. Later, when the canal was constructed during the war, with speed one of the main requirements, it was found essential to discharge it directly into the Saguenay through a rock cut that could be excavated throughout the winter, thus saving valuable time.

To permit development by stages, it was decided to install 300,000 horsepower of generators in the Chute a Caron dam, which was thrown across the river to control the level of the intake. While this plant did not use the full head, it would be helpful as a standby upon completion of the larger powerhouse lower down. Also, it could take advantage of the seasonal overflow at high water. As it turned out, the depression came along before the main

# n the Saguenay

Shipshaw canal and power station were started, so Shipshaw No. 1 (as the Chute a Caron plant is now called) and Ile Maligne had to carry the whole load during the first years of the war.

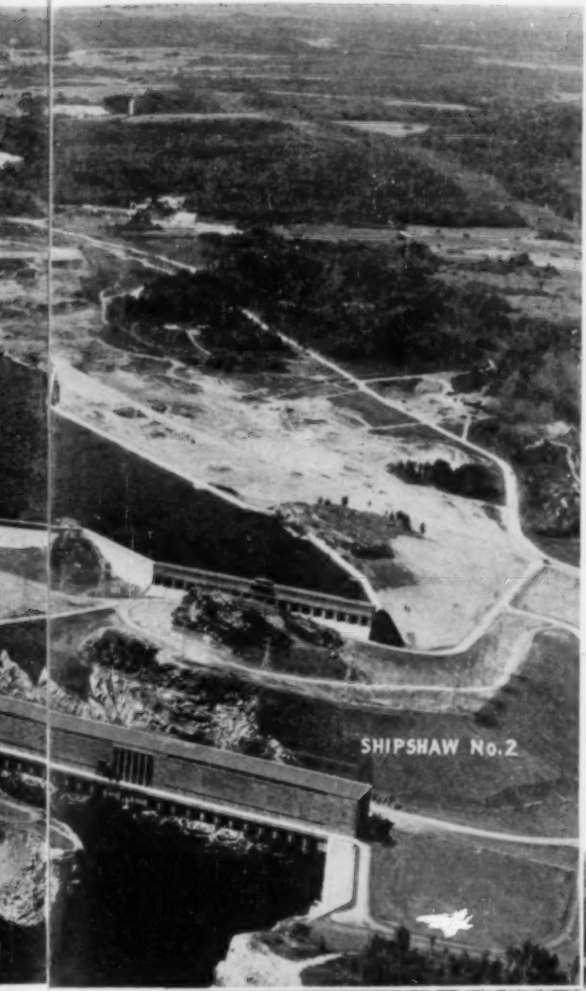
Meantime, the aluminum works at Arvida had been built up to a capacity of 80,000 tons annually, and its total output was required soon after the outbreak of hostilities in 1939. After the fall of France in 1940, when the full gravity of the war situation had to be faced, it was seen that Canada was Britain's main recourse for metal to expand her aerial armadas, and in Canada it devolved chiefly upon the Arvida plant and Saguenay power to meet the emergency. When the United States entered the conflict. the pressure for aluminum became still more acute, but by that time auxiliary plants in other parts of Quebec had been established and the great Shipshaw No. 2 powerhouse was well underway, with H. G. Acres as consulting engineer and the Foundation Company of Canada as general contractor.

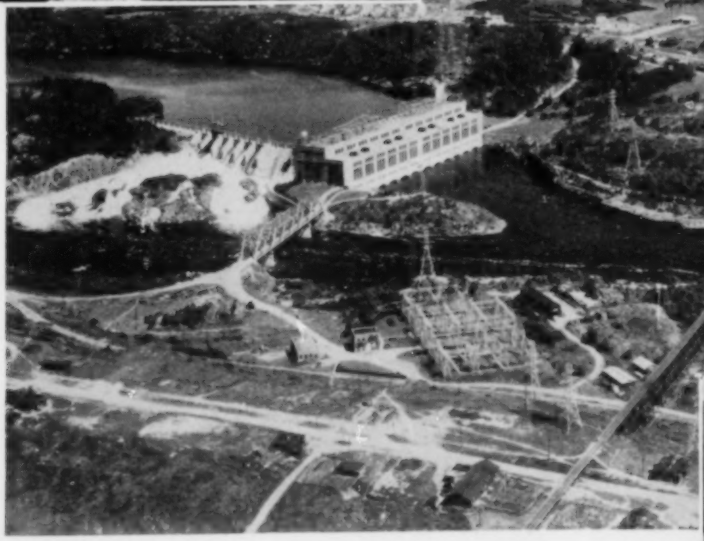
The main features of the Shipshaw project are indicated in an accompanying drawing. The longer section of the 8000-foot canal between the control gates and the headblock runs through natural depressions and earth excavations, only the shorter stretch requiring rock cuts. It was intended at first to place earth fills at five low points, but concrete dams that could be reared during the winter season were constructed instead in order to save time. The rock cut, about midway of the canal, has a maximum depth of 105 feet and is 300 feet wide. The headblock was conveniently sited on bedrock after a moderate amount of excavating. Six 30-foot tunnels take the water to twelve 100,000-hp. turbines. The tailrace is at tidewater.

One of the best-known waterpower developments on this continent is the vast Boulder Dam project on the Colorado River. Unlike the Saguenay, where hydroelectric energy is the principal objective, Boulder Dam's primary purposes are flood prevention, water for irrigation, and water for domestic use, with power as a profitable by-product. In spite of this essential difference between the two, it might be instructive to compare some of their main features because it should help us to determine why electric energy from the Saguenay and other large Canadian sources is so low in cost, as compared with waterpower in the United States.

In looking over the accompanying table, the item that probably affects the cost of power most is that of firm power—power that is dependable twelve months in the year, year in and year out. So far as that is concerned, almost two-thirds of the investment at Boulder Dam brings in a return for only a part of the year. At Shipshaw, the electrical load and the income are, to all intents and purposes, continuous. A somewhat similar situation will arise in Canada when the St. Lawrence deep waterway and its attendant power sites at Cornwall (international) and Lachine (Canadian) are developed. From the Canadian point of view those sites are not economical for power development alone; but with a reasonable percentage of the outlay charged against navigation, the cost of the electric current may be comparable to that from the Saguenay, the St. Maurice, or the Beauharnois.

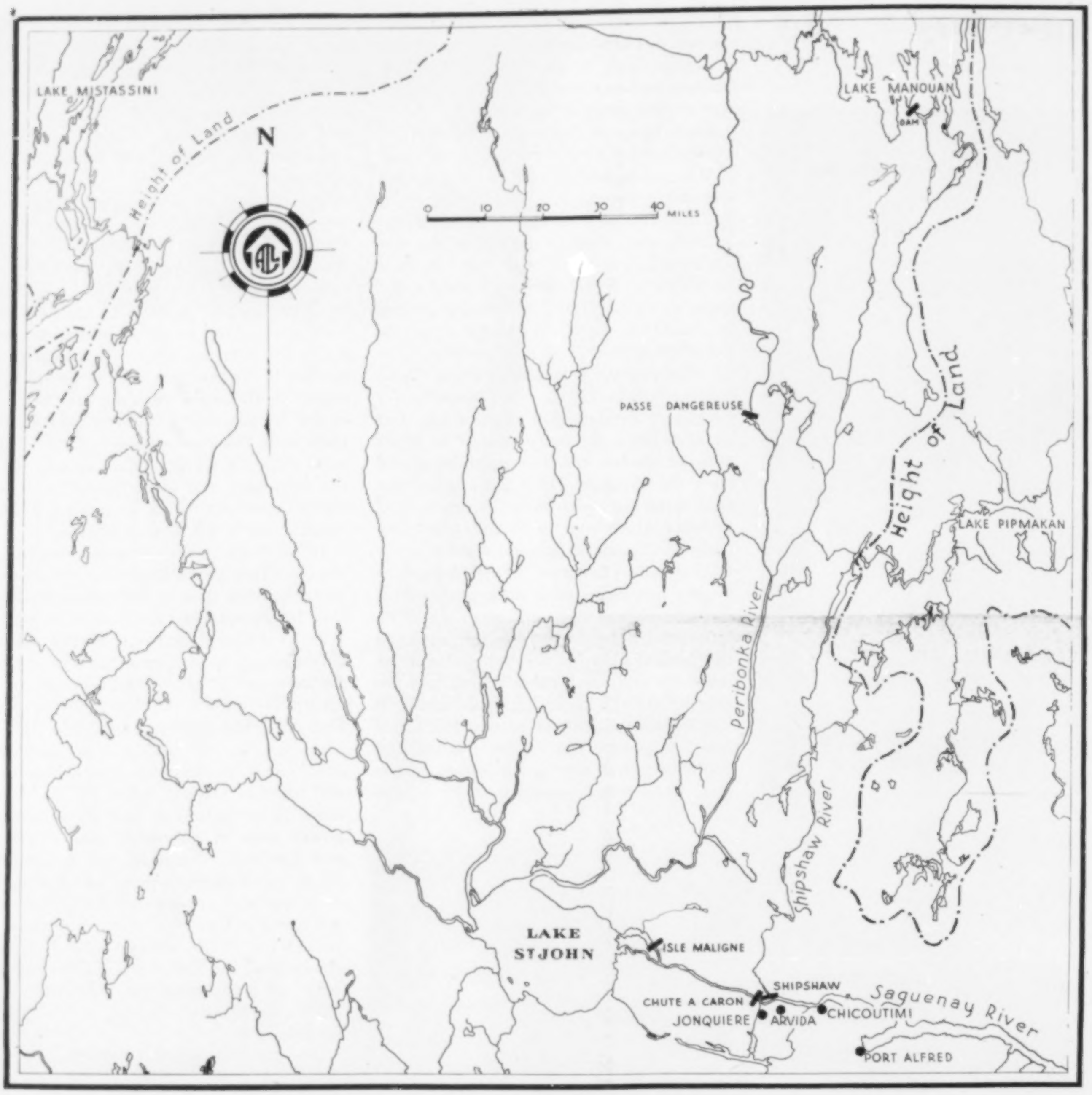
A second point of comparison is the construction cost, which, of course, is in favor of Shipshaw in spite of the urgency for speed because of wartime. The rock excavation there was mainly in the open cut for the canal, whereas the large tunnels accounted for a considerable part of it at Boulder Dam. The Shipshaw concrete structures are of little consequence along-





**SAGUENAY-POWER TRIUMVIRATE**

The Isle Maligne (540,000-hp.) development that utilizes one-third of the river's fall is shown just above. Shipshaw No. 1 (300,000 hp.) and Shipshaw No. 2 (1,200,000 hp.) powerhouses appear in the large view. The latter plant (end view at top-left) is 837 feet long. The control boards for its twelve 100,000-hp. generators are seen at the right.



**WATERSHED OF LAKE ST. JOHN**

From this drainage area of only 30,000 square miles is collected enough water to generate more than 2,000,000 hp. of electrical energy the year round. The reason for this is found in the high precipitation, 35 inches of water annually, plus the multitude of lakes that constitute natural storage reservoirs. James B. Duke, American tobacco king, had the vision that materialized in this huge power development. He and Sir William Price carried through the first stage—the construction of Isle Maligne power plant and the incidental erection of dams at Lake Manouan and Passe Dangereuse to increase storage facilities. Duke originally intended to use this power, as well as that still to be developed downstream on the Saguenay, for the fixation of nitrogen, but the subsequent expansion of the aluminum industry created another outlet for it. The project at Chute a Caron (now Shipshaw No. 1) and wartime Shipshaw No. 2 were enterprises of the Aluminum Company of Canada. Arthur Vining Davis, for whom the Canadian aluminum center of Arvida is named, played a prominent part in planning them.

side the towering mass that holds back the mighty Colorado.

Other advantages enjoyed by most rivers in Canada, including the Saguenay, are the relatively heavy and even precipitation (34.8 inches annual average in the Saguenay watershed) and the steady run-off. Thus a small watershed can provide a lot of power, and storage is a comparatively simple matter. The two impounding dams built in connection with the Shipshaw development have a combined capacity of 260 million cubic feet of water and cost more than $13,000,000.

Some of the engineering and constructional features of the latter project are of general interest. The canal between the control gates and the headblock, a distance of 8000 feet, is 500 feet wide at the bottom in the earth cuts and 300 feet in the rock cut, with a depth of water from 27 to 33 feet. The section was made large enough to reduce the flow to a point where the surface would freeze during the winter so as to prevent the formation of frazil ice, that curse of Canadian power plants experienced only in fast-flowing open water. Results have shown that this precaution at Shipshaw has had the intended effect.

The control works at the head of the canal have a length of 384 feet and contain six steel gates each with a clear opening of 50 feet. While it might, at first glance, seem unnecessary to have gates in the channel at this point there were several reasons why it was expedient to install them. In the first place, when construction was started, there was no assurance that the headblock and power plant would not be the target of enemy bombers—in fact, a strong detachment of Royal Canadian Air Force pursuit planes and antiaircraft batteries were maintained in the vicinity until the end of the war. Without the control works, repair of the headblock, power plant, and canal would have necessitated lowering the river for a distance of 27 miles upstream to Grand Décharge and putting the Ile Maligne plant out of commission at a time when it was most needed.

The decision to use shafts and tunnels rather than penstocks between the headblock and the turbines was dictated by a number of considerations: first, the comparative vulnerability to enemy attack; next, the scarcity of steel of which the penstocks would have required 8000 tons. The Canadian winter was another factor in favor of tunnels. Events, quite apart from war conditions, have fully justified the choice. The rock, anorthosite, proved to be ideal for drilling and breaking, and no fissures or leaks of any consequence were found during construction or since. The contractors and workmen showed such spirit and skill that the underground schedules, as well as all others on the entire job, were completed on time.

The site selected for the tailrace proved to be the most advantageous of the whole program. Its position had been determined by the location of the headblock on a ridge of rock with a downstream slope toward the powerhouse. Between the latter and the river was a flat bank, 600 feet wide, beneath which drilling revealed an old channel filled mainly with gravel. Thus excavating for the tailrace, as well as for a considerable part of the power-plant substructure, was done mostly "in the dry."

Along the bank of the Saguenay there was a rock formation and part of it was left as a dam to keep the river water out of the tailrace. This formation was 310 feet long, 35 feet high, and 22 to 52 feet across the top. It was drilled and blasted with 40 tons of dynamite, some of the material falling into the river and some into the adjoining tailrace where a trench 10 feet deep had been prepared to receive it.

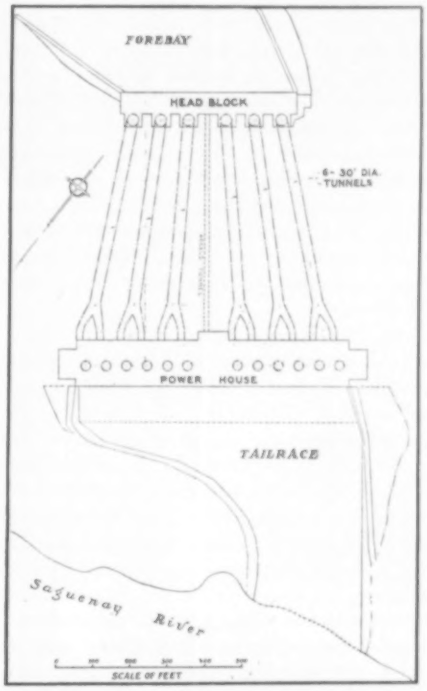
Shipshaw No. 2 is notable for having, at least at present, the world's largest concentration of power under one roof, the twelve generators installed there having a capacity of 100,000 hp. each. The coördinated Saguenay development is designed with a view to running these twelve units continuously, and the adjoining Shipshaw No. 1 plant, with its standby generators, will provide energy during inspection, overhaul, and emergencies.

| Boulder Dam | | Shipshaw |
|---|---|---|
| 245,000 sq. miles | Watershed | 30,000 sq. miles |
| 30,500,000 acre-feet | Water storage | 9,183,000 acre-feet |
| Governed by needs of irrigation | Regulated flow | 42,500 cfs. at present<br>50,000 cfs. ultimate |
| 520 ft. (average) | Head | 208 ft. |
| 2 | Number of power plants | 2 |
| 1,835,000 hp.* | Installed power | 1,500,000 hp.** |
| 663,000 hp. | Firm power | 950,000 hp.** |
| 1,137,000 hp. | Seasonal power | 550,000 hp. |
| Nil | Excavation, earth | 3,265,000 cu. yds. |
| 3,500,000 cu. yds. | Excavation, rock | 2,648,000 cu. yds. |
| 24,000 ft. | Total length of tunnels | 3,600 ft. |
| $135,000,000 (to June 30, 1945) | Cost | More than $110,000,000*** |

*Ultimate capacity. Present generating capacity 1,420,000 hp.

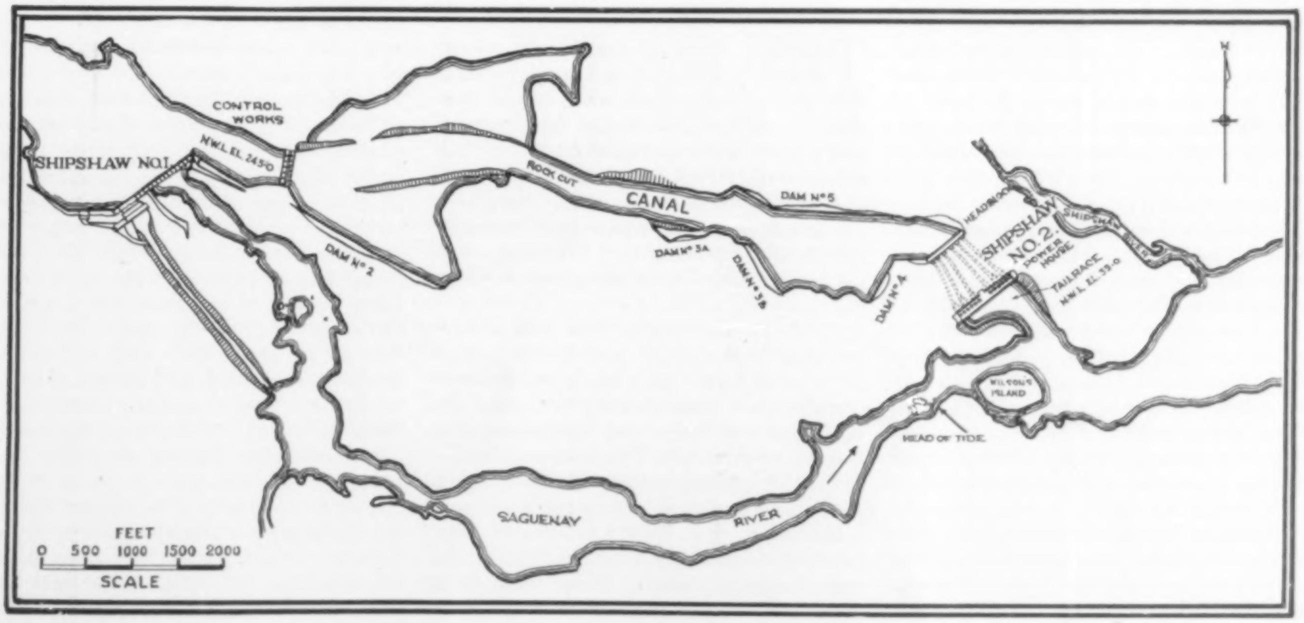
**There is 540,000 hp. installed at the upper site, Ile Maligne, which is not included in any of these figures.

***Including storage works.

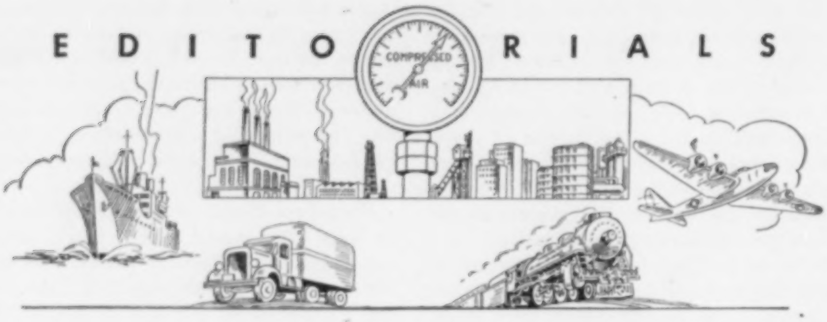


**SHIPSHAW PLAN**

Shipshaw No. 1 power plant was built in 1928. The remainder of the development—including the canal, No. 2 powerhouse, and appurtenant works—was completed at record speed to provide additional power needed for aluminum manufacture during the recent war. The drawing at the right shows details of the works for delivering water to the turbines of No. 2 powerhouse.



# EDITORIALS



## "OUR EQUIPMENT FRIENDS"

THE Morrison-Knudsen Company, Inc., is probably the world's largest firm of general contractors. Its operations extend not only to nearly every section of the United States but also to various other parts of the world. Before and during the war it had several units building military bases on islands in the Pacific, and even now it is operating as far from home as South America and China. It was organized in 1912, and before attaining national prominence as a member of Six Companies Inc., builder of Boulder Dam, had completed $30,000,000 worth of contracts in the West. Since then it has expanded to its present huge proportions.

In M-K's main office in Boise, Idaho, its president, Harry W. Morrison, keeps a hand on the pulse of his far-flung organization. Somehow, despite the continually growing scope of its work, he maintains a surprisingly intimate contact with all the activities and the men that direct them. Morrison-Knudsen is so large and so widely scattered that it publishes a company magazine, *The Em-Kayan*, to keep its personnel informed about what is going on. Harry Morrison heads the editorial committee, and in each monthly issue he has a signed editorial on some pertinent topic that appears under the informal heading, *President's Memo*. His subject in a recent number was *Our Equipment Friends*, and what he wrote should warm the heart of every manufacturer of construction machinery. With permission, we reprint it here:

"In the typical rough-and-ready banter of construction men it is a custom and habit to berate the fellows who sell us equipment and materials—to blame them for most of our troubles and all our shortages. Actually, such name-calling is mainly harmless frivolity that hides many a solid friendship of long standing between dirt stiffs and their suppliers. But a newcomer in the business sometimes is misled into taking these things seriously and treating a supplier with scant respect.

"Speaking for M-K, in the course of our company's experience over the past 30 years, we have been aided in countless ways by the men and their companies who make or sell equipment. Often in our early struggles the service they rendered far exceeded the importance of our purchases and helped us to survive. Certainly we did not prosper by biting that hand—and would not expect to do so now.

"There is an unbreakable bond of mutual dependence between construction firms and equipment people. Heavy-duty earth and concrete machines are designed and built to solve our working problems, and every improvement in them advances our operations. While bound by war restrictions and priorities that prevented normal deliveries, many equipment men went far afield to help find parts and supplies for customers to keep their old rigs rolling. In a very real sense their business is our business, and vice versa.

"It has been our experience, in fact, that in dealings with established business firms in all lines, the character of service you receive can be influenced by the consideration you show the supplier's viewpoint—and, of course, by the credit standing you maintain.

"Friends are a great asset in construction, as in any other business, and there is no better or easier place to find them than among the people from whom you buy."

●

## THE MACHINE AGE

TAKING stock of the highly mechanized sphere in which we live, it is difficult to realize that most of our machinery has been developed in a century and a half. But, to remind ourselves that this is true, let us look back briefly into the early days of our nation. Here is a paragraph on *Manufactures and Mechanic Arts* from Barnes's history that some of us carried to school around the turn of the century:

"The Revolutionary War was fought by men clad mainly in homespun, and using a flint-lock hunting rifle. Manufactures had been steadily repressed by the mother country, and agriculture was the favorite pursuit. The mechanic arts—save shipbuilding in New England—had made little progress. The farm house was a manufactory of all the articles of daily use. Clothes, hats, shoes, and harnesses were made at home. Even nails were hammered out in the winter time. The hand-cart, spinning-wheel, and loom were common pieces of furniture. The land was turned by a plow whose mold-board was faced with strips of iron made by straightening old horseshoes. The grass was cut by a scythe; the grain by a sickle. Wheat, oats, rye, etc., were threshed out on the barn floor with a flail, or trodden out by cattle. The flax and wool were carded, spun, and woven into cloth by the women of the household."

The contrast with present conditions is striking. America has reached its current leading position in world economy through sustained technological advance. Of greatest effect among the early labor-saving machines was Whitney's cotton gin. Prior to its advent, the cleaning of a pound of cotton required a day's labor. The gin made cotton-raising profitable and started a great industry.

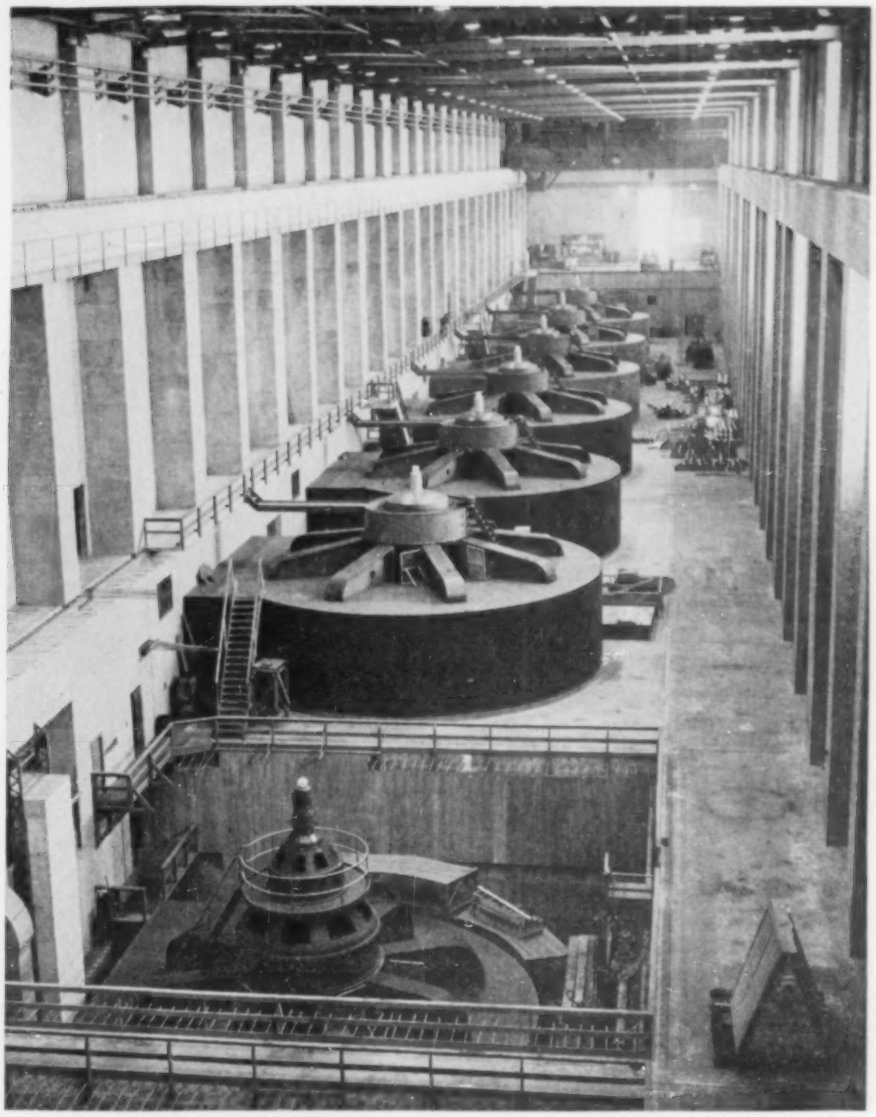
Other industries were launched in a similar manner. Their growth was stimulated by the laying of railroads and the stringing of telegraph wires, which promoted the colonization of vast areas, provided means for transporting raw materials and finished goods, and speeded up communications. Then came a veritable flood of mechanical innovations, and it still shows no signs of subsiding. With each invention, new factories arose, and the factories have, in turn, become more and more mechanized. Wars and periods of labor shortages and high wages, which are more or less concurrent, have always stimulated mechanization, and right now we are at the crest of a movement of this kind.

Just where all this will lead us, no one can say. Meanwhile, it is interesting to observe some of the peculiar twists and turns of the mechanical age. As machines increase, labor expenditure per unit of production decreases. Ways are continually being found to make machinery more automatic and to link batteries of machines together so that the movements of all are subject to one control. In some industries, entire plants are operated by only a few attendants.

To accomplish this, however, machines are necessarily becoming more and more complicated. Keeping them in proper repair is a specialized job, handled by a separate corps of men. Maintenance is becoming progressively more important, and there are factories where that work requires more men than are in the operating crews. If the trend continues, we can conceivably reach a point where there will be three or four men engaged in keeping machinery in running order to every man who is actually operating it. Some observers who have given the matter considerable thought go so far as to place the ultimate ratio at seven to one. Regardless of how far it will go, there is no mistaking the trend. Apparently, the Jack of the future will not be a master of all trades. He most likely will be a maintenance man.

# Concrete Surgery at Grand Coulee

S. E. Hutton



U. S. Bureau of Reclamation photos

**WEST POWERHOUSE AT GRAND COULEE**

In the foreground is one of the two 75,000-kw. generators that were built for Shasta Dam but placed in service at Grand Coulee to tide over the war emergency. These units have now been removed, and preparations are being made to put in three additional permanent 108,000-kw. units like the six shown in the background. Details of the work of removing the concrete in which the Shasta generators and their turbines were set are pictured on the two following pages.

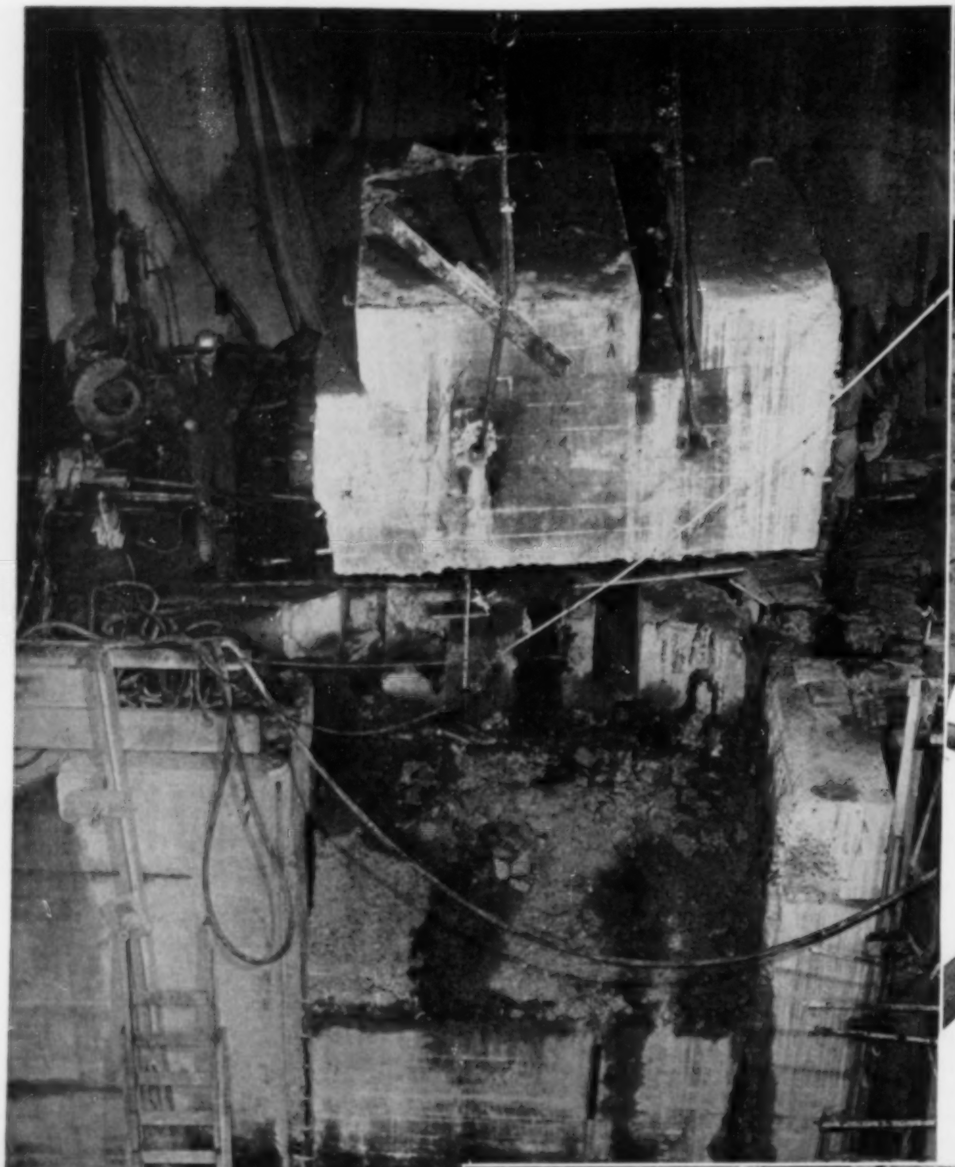
THE ticklish job of removing more than 6500 cubic yards of reinforced concrete from the west powerhouse at Grand Coulee Dam without harming millions of dollars worth of generators and other precision equipment is virtually completed. Compressed air, which played a major part in the building of man's largest dam, served equally well in the painstaking work of freeing two 75,000-kw. generating units from their concrete foundations at Grand Coulee Dam preparatory to their transfer to the Bureau of Reclamation's Shasta Dam in California for which they were constructed.

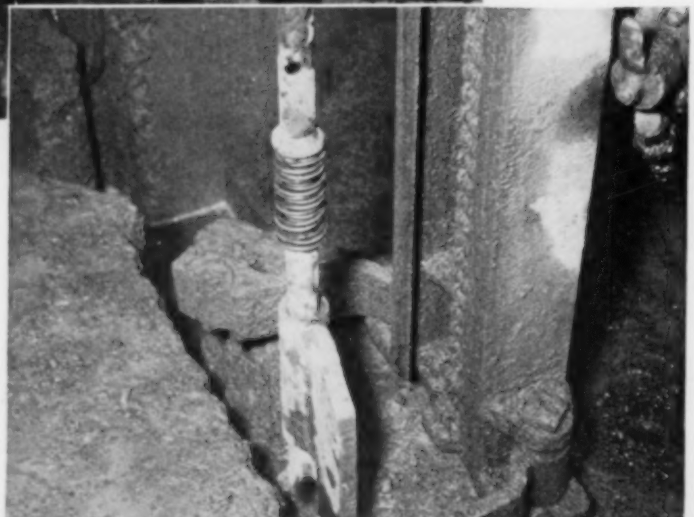
Drafted into service at the Grand Coulee Dam in eastern Washington to meet the heavy wartime needs of industry, the two units had to be installed as permanently as their larger companions, the 108,000-kw. generators regularly on duty there. On February 25, 1943, the first Shasta unit went on the line, and on May 7 its sister unit began operating. During the war, these two generators turned out more than three billion kilowatt-hours of electrical energy for shipyards, aircraft factories, the atomic-bomb plant at Hanford, Wash., aluminum and magnesium producers, and other essential installations in the Pacific Northwest.

In the fall of 1945, having served their purpose, the Bureau of Reclamation ordered removal of the units, and engineers were faced with the task of taking out the thousands of tons of rock-hard concrete that locked them in place. Use of explosives was out of the question, because a sudden jolt would have jeopardized not only the Shasta generators but also the larger 108,000-kw. units nearby. A variation of quarrying, with widespread application of compressed-air tools, was adopted by J. E. Wallace, master mechanic for installation and maintenance. Compressed-air lines, served by a main compressor station located outside the powerhouse, were brought into play.

The bays occupied by the Shasta units were shut off from the remainder of the power station by partitions, and drilling began on December 3, 1945. Principal cutting was done with wagon drills provided with special guides manufactured in the bureau's shops at the dam. These guides spaced the holes evenly, eliminated guesswork, and expedited the program. Reinforcing steel was encountered frequently, and drillers and cutters worked as a team in handling a block. When a drill came in contact with embedded steel, the cutter took over with a torch and cleared away the obstruction. Guides were utilized only with the wagon drills, and the life of each was short. The drillers found that the abrasive action of the concrete rapidly enlarged the guide hole and limited the use of the device to one shift. Approximately 1000 guides were required for the quarrying job.

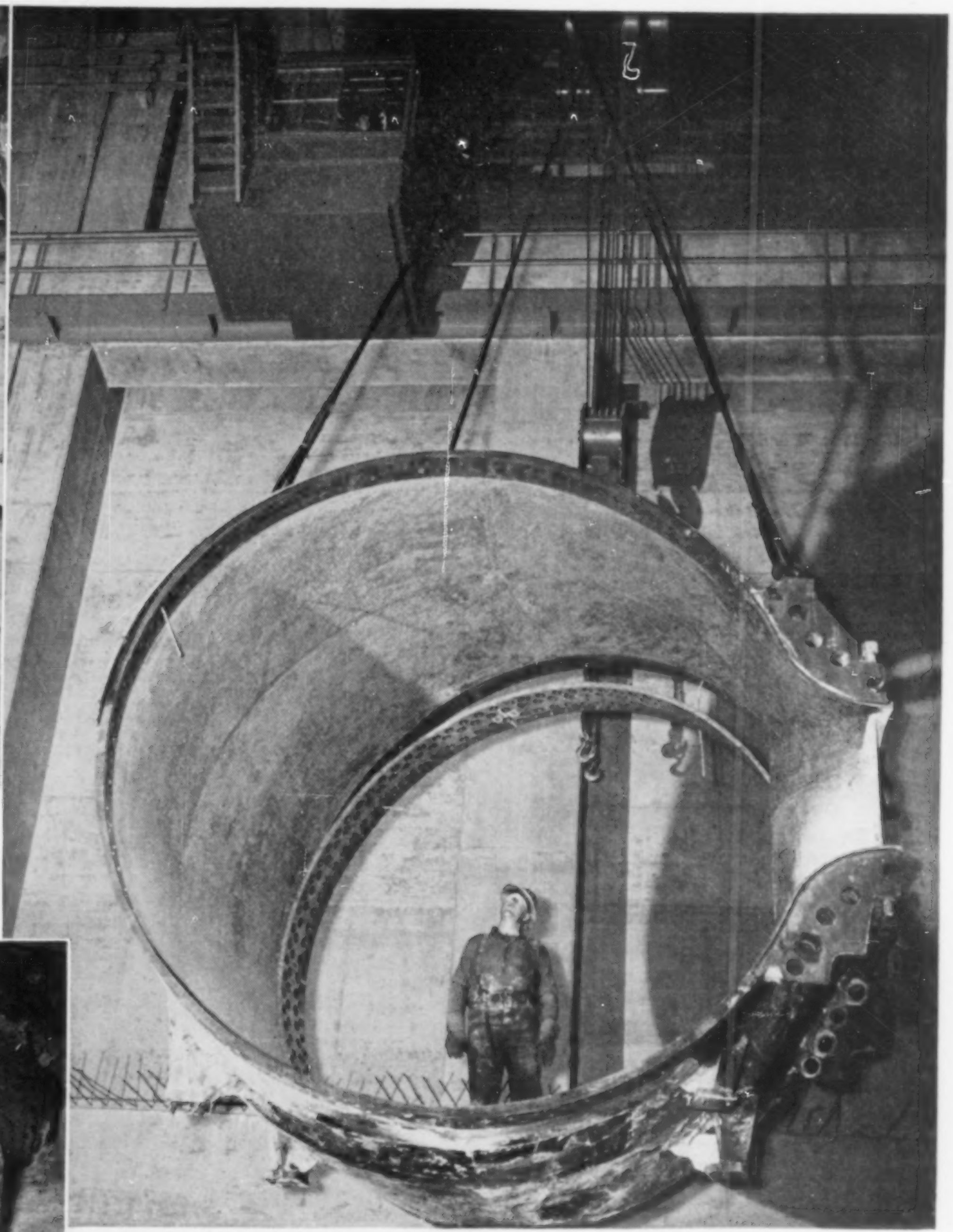
When all four sides of a block had been drilled, jacks and wedges were inserted to break the mass of concrete free. The overhead crane, which is a permanent feature of the powerhouse, lifted the

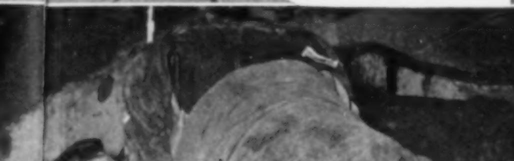




**QUARRYING IN A POWERHOUSE**

With the use of dynamite prohibited lest the precision-built machinery be damaged, most of the 6500 cubic yards of concrete was removed in blocks that were cut loose by line drilling with wagon drills. One of the huge chunks is shown above as it is lifted from the bay by the station's overhead traveling crane. A wagon drill may be seen behind the man at the left. Drill holes were spaced evenly by means of special guides, such as the one illustrated at the right, and the guide bar was inserted 10 inches into the hole. The sleeve for the drill rod was made of chrome-nickel steel to resist abrasion. Where the drill bit encountered reinforcing steel, the latter was cut with an acetylene torch (bottom-center.) Concrete encasing the scroll cases of the turbines was chipped away with hand-held hammers, as pictured at the top-center. A 10-ton section of a scroll case, freed from its concrete sheath and hoisted from the bay, is seen at the extreme right.





blocks from the bays and transported them to the station exit. There they were loaded on railroad cars and trucks for use in riverbank stabilization below the dam.

Removal of concrete from the embedded scroll cases of the 103,000-hp. turbines was a particularly difficult task. Much of this material was cut away with hand-held chipping hammers so that there would be no likelihood of damaging the valuable cases. After most of the concrete had been chipped away, the overhead crane was employed to pull the various sections of the scroll cases free and to carry them from the working area.

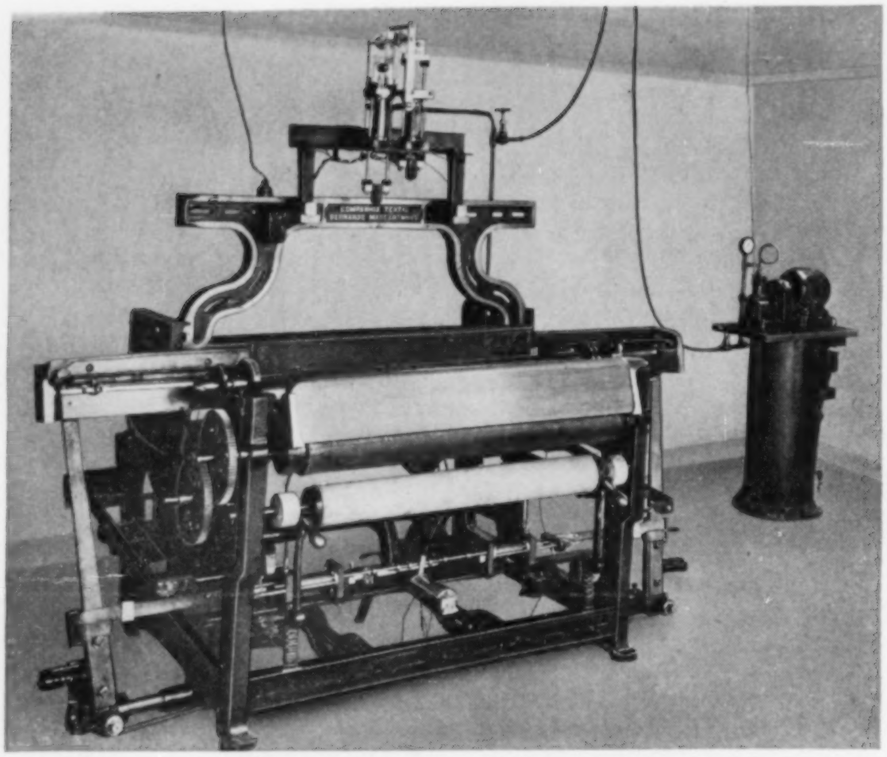
Several dust-control measures were adopted to prevent harming other installations in the power plant. Air was recirculated by spray-equipped fans, and water was used on the wagon drills. Increased pressure in the enclosure (due to the operation of air tools) caused some of the dust-laden air to move toward other parts of the station, but this danger was overcome by utilizing exhaust fans to draw the excess air from the partitioned zone and to equalize the pressure. The fans were installed high above the working area, where the air was relatively free of dust.

With all the unnecessary concrete removed from the bays housing the Shasta units, the Bureau will begin setting up three 108,000-kw. generators, bringing the total of such units at Grand Coulee Dam to nine. Then, again, compressed-air equipment will be used continually in assembling the scroll cases for the 150,000-hp. turbines and for the performance of a variety of other jobs incidental to the installation of the world's largest generating units.

# Air-Powered Loom with Novel Features

### Anna M. Hoffmann

Illustrations from "Textile World"



**AIR OPERATION—ELECTRIC CONTROL**

The small compressor at the right supplies sufficient air to operate the new loom at speeds comparable to those of the conventional type. The principal features of the Mascarenhas machine are a stationary lay, novel beating-up mechanisms, and air operation. These, combined, have helped to reduce vibration to the point permitting a frame of lighter than usual construction. The two pneumatic cylinders at the top lift and lower the harnesses that change the shed through which the shuttle travels. At the left is one of the kicker sticks in shuttle-throwing position. The air cylinders that do the "picking" are horizontally disposed below the bottom roll on the front of the loom.

INTEREST in the textile industry is centered today on an electropneumatic loom that promises to reverse the present trend in loom construction. In order to eliminate vibration induced by high operating speeds, the tendency is to build machines with massive frames so as to increase their weight. By contrast, the new loom permits of lighter frame construction because much of the usual vibration is eliminated by the use of a stationary instead of the customary movable lay and by applying power direct to the principal working parts instead of serially from a common source such as a motor. To be more explicit, the rotary motion necessary in weaving with a standard-type shuttle loom and which is converted into reciprocating motion through a complex series of gears, cams, and levers, is eliminated in the new machine.

The electropneumatic loom is the invention of Eneas G. Mascarenhas of Brazil, and tests with it have proved so successful, it is claimed, that a company has been formed in that country for its manufacture. As described by Harold E. Reed in a recent issue of the *Textile World*, a compressor provides the motive energy for the weaving mechanisms, and electricity controls the sequence of operations. This arrangement is of twofold advantage: compressed air, being a flexible fluid force, makes it possible to actuate the harnesses, the beat-up mechanisms, and the picker sticks with any desired power ranging from that of a trip hammer to that of a light touch, while control of the air valves through electromagnets and relays permits split-second timing of the successive steps in each cycle. Further, the electropneumatic principle may be applied to make a loom fully automatic.

Before describing how the new machine works, it might be well to define some of the terms or parts of a loom so that the layman will have a better understanding of the text that follows. In weaving, "shedding" means dividing the threads of the warp horizontally to form a shed or passageway for the shuttle. Throwing the shuttle through the shed is known in the industry as "picking." The lay, in the conventional type of machine, is the swinging bar that "beats up" each weft thread or pick to the fell or the cloth already woven. The reed performs a number of functions and is so named because it was originally made of a succession of canes. It is a comb-like arrangement of flattened steel wires or dents that are fixed in a frame and serve to keep the warp threads in position and determine the number of threads per inch, an indication of the quality of a fabric.

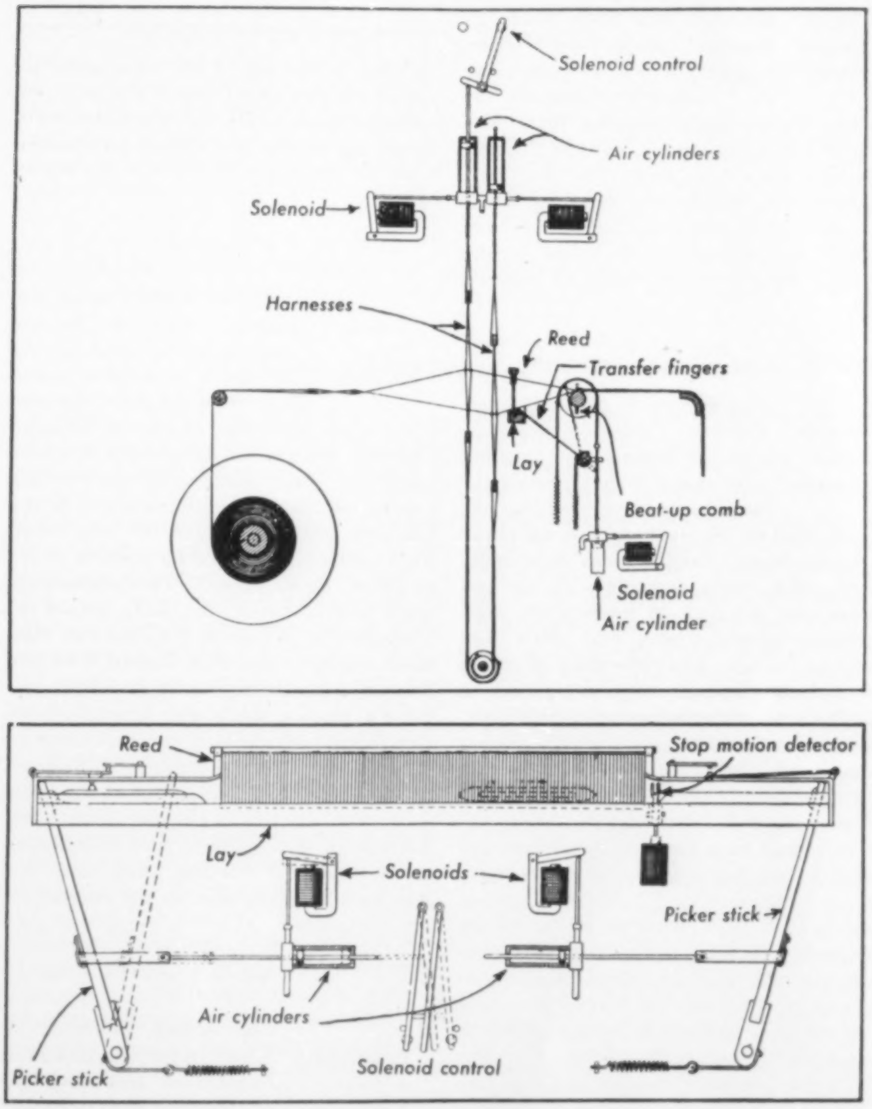
Shedding, picking, and beat-up operations are all performed by means of single-acting pneumatic cylinders which, in the case of the experimental loom, were supplied with air by a $1/6$-hp. compressor. Shedding is done by sets of vertically disposed units through the medium of harnesses, the number of the latter that can be used being limited only by the number of cylinders that can be installed. The harnesses are attached to the pistons, as shown in an accompanying drawing, and the two cylinders in each set work in reverse. In other words, when one piston is forced upward by the admission of air, the other moves down, carrying the harnesses along with them and changing the shed after each passage of the shuttle. The length of time the shed is open can be varied by adjusting the timing of the electromagnets which control the air valves. Shock is prevented on the piston upstroke by trapping in the top of the cylinder just enough of the exhaust air to form a cushion. Efforts are now being made to manipulate the harnesses with double-acting units. If they are successful, then only half the number of cylinders will be required for the shedding operation.

Now we come to picking, which requires the services of two pneumatic cylinders. These function alternately, operating first one and then the other picker stick to keep the shuttle moving to and fro. Control of the air supply or valves is effected through rods that are connected to the sticks in such a way as to make and break electric contacts, while springs return the sticks to their outermost positions. The impact with which the pickers strike the shuttle to throw it through the shed can be regulated by varying the size of the cylinders as well as the air pressure. Traveling along the race board, the shuttle enters either of the board's boxlike extensions, thus forcing a projection outward and closing a switch which, in turn, causes the shuttle to be properly boxed until the change of the shed. These switches also serve to actuate other electrical devices that control other loom movements.

One of the outstanding features of the Mascarenhas loom is that the lay, unlike that of other types, is stationary, a change in construction which is said to give the pneumatic unit many advantages over the familiar machine. For one thing, it permits placing the harnesses close to the lay, with the result that there is considerable reduction in the depth of the shed and little strain is placed on the warp ends. Further, the work of picking and changing bobbins in the shuttle is simplified, the flying shuttle is much less of a hazard, and beating-up is done by mechanisms of novel design.

Beating-up is performed in two stages: by transfer fingers and a beat-up comb. The former are long and flexible and spaced in series at definite intervals between the warp threads. They are secured to a rotating drum and move transversely through the shed. The lay is slotted, permitting the fingers to lie beneath it when they are idle so that the shuttle has free passageway over them. Resting on these fingers, the filling or weft trailing from the shuttle is carried by them to the fell of the cloth when the drum turns.

Structurally, the beat-up comb that finishes the work differs little from the other unit. It is made up of shorter and stronger fingers and more of them, while the drum to which they are attached is larger. With the fabric lying on the drum, this series of fingers actually beats the filling into place against the fell of the textile. The action of the comb can be regulated so that virtually any kind of fabric, from sheer to duck, can be woven without danger of damaging it. This rocking-method of beating-up the weft has measurably helped to reduce vibration, which normally loosens nuts and detroys settings. Both sets of fingers are operated by air cylinders through solenoid-controlled valves and are returned to their starting positions by tension springs. The cloth take-up motion is of the customary pawl-and-ratchet type, and electropneumatic means are used to start and stop the loom.



MECHANICAL FEATURES

Top drawing illustrates how the harnesses are raised and lowered and the transfer fingers and beat-up comb (bottom right) are actuated by solenoid-controlled air cylinders. Arrangement of the picker sticks and their control mechanisms are shown in the bottom sketch. The new loom is said to have 95 fewer moving parts than the standard type, and is so designed that when one fails to function the machine stops instantly.

## Lean Ore for Backfilling

WORK is underway by the Consolidated Mining & Smelting Company on a $3,000,000 project that, among other vital considerations, will make it possible to handle low-grade ore from its Sullivan Mine at Kimberly, B. C., at a profit. The program includes a 4-mile haulageway, an underground crushing plant, and a sink-and-float plant to be erected at the site of the present concentrator.

A 12,400-foot tunnel, 10x12-feet in section, will be driven on the 3650-foot level to the surface, where a narrow-gauge rail connection, 8300 feet long, will be built to the sink-and-float plant, thus reducing the run from portal to mill by 4900 feet. The crushing plant will be centrally located in the mine and will consist of a 36x48-inch jaw crusher and a 7-foot Symons cone crusher. This installation will reduce all the ore that is produced to a minimum of 1 inch and discharge it directly into a 15,000-ton storage pocket, from which it will be dumped into 450-cubic-foot cars for haulage by a 40-ton locomotive to a bin at the sink-and-float plant.

The latter will have an ultimate capacity of 500 tons an hour and will use galena as the separating medium. With a maximum-size feed of 1½ inches, and a flow rate of 400 tons an hour, it is computed that from 2500 to 2800 tons of very lean material will be discarded daily as float. Mixed with about 10 percent of mill tailings, it will go back into the mine for use as backfilling, for the Sullivan is worked by the room-and-pillar system. Gravel now serves for the purpose, but sources of supply close to the property are limited. Furthermore, though satisfactory for the purpose at upper levels, it will not support the loads that will be encountered at greater depth. The crushed waste material and sulphides combined will meet that requirement and, in addition, will be available in large quantities at low cost. Summed up, it will be cheaper to dispose of the low-grade ore in this way than to treat it in the existing mill, as it is today. Contract for the tunnel has been awarded, and the entire undertaking is scheduled for completion in about eighteen months.

# This and That

**Unique Power Scheme**

The Hydro-Electric Power Commission of Egypt is making preliminary studies of a novel power-development scheme that would make use of sea water. West of the delta of the Nile River is a depression, 770 square miles in area, called the Quattara. Its lowest point is 450 feet below sea level, and it would hold 280 cubic miles of water if filled to sea level. The project envisions bringing in water from the Mediterranean through a 12-mile channel and a 28-mile tunnel and dropping it to turbines in a powerhouse 165 feet below sea level. It is proposed to dispose of the incoming water by evaporation. Members of the Egyptian commission were in the United States in August conferring with American engineers regarding the Quattara scheme and also a generating station that is to be built at Aswan Dam on the Nile. The latter is to generate 280,000 kw. and cost around $40,000,000. American firms have been asked to bid on its construction.

* * *

**Earth Heats, Cools**

After three years of experimentation, Robert C. Webber, Indianapolis, Ind., inventor, is preparing to manufacture equipment that is designed to make use of the earth's natural temperature for home heating in winter and cooling in summer. It is reported to function this way: Coils of tubing are buried below the frost line, where the ground temperature changes little throughout the year. To obtain warmth from the soil in winter, a refrigerant, Freon, is circulated through the tubing in liquid form. Vaporized by the transfer of heat, it flows upward into a compressor where the work done on it heats it still more. Then it goes through additional coils, over which air is blown to absorb some of the heat. The air is circulated through register outlets to heat the house. In giving up heat, the Freon is liquefied and again ready to repeat the circuit. By reversing the cycle in summer, when the earth is cooler than the house atmosphere, a cooling effect is obtained. Webber states that he kept his home at a temperature of 76°F. last winter when the thermometer outside registered below zero. During the past summer the same unit served to keep his house comfortably cool.

**"These college football players are funny. They work like mad all morning and exercise during their lunch hour."**

* * *

**Novel Use of Hose**

A canning company in Maine transfers fish from boats to storage tanks on shore through a 6-inch hose, The B. F. Goodrich Company reports. To prevent damaging them, the fish float in water that is pumped through the hose into a 12-inch pipe that discharges them into the storage tanks. They can thus be handled at the rate of 2500 pounds per minute, or six times as fast as by conventional methods of unloading.

* * *

**Doctor Moss Passes**

Dr. Sanford A. Moss, General Electric Company scientist who developed the airplane supercharger that proved invaluable to our wartime air forces, died on November 10 at his home in Lynn, Mass. Doctor Moss spent most of his adult years working with air and steam and received 46 patents on compressors, superchargers, and other mechanical devices. His pioneering efforts in gas-turbine research were recounted in our Fiftieth Anniversary issue last March. On the cover of that issue we showed an early rock drill and received the following comment on it from Doctor Moss: "Beginning in 1889, I served a machinist apprenticeship in a shop in San Francisco making rock drills exactly like that one." During World War I, the Government requested Doctor Moss to work on the problem of giving military airplanes more power. His answer, developed in cooperation with the Air Corps, was the now famous turbosupercharger, which is essentially a combination of a compressor and a gas turbine. The war ended before it could be generally applied, and there was little demand for it until World War II clouds gathered. By that time Doctor Moss had been retired by General Electric, and the day in 1938 when the Munich pact was signed he was in London. Sensing what was ahead, he returned to America and, at the age of 67, voluntarily resumed his post as a General Electric consulting engineer. He was the recipient of numerous awards and official commendations for his contributions to the supercharger.

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**Truck Tire Pioneer**

Martin D. Scott, whom the Goodyear Tire & Rubber Company credits with having done much to develop pneumatic tires for long-distance truck operations, died at Akron, Ohio, in October. He was the company's first test-car driver, and later turned to running trucks and then to training drivers. When the first pneumatic tires for long hauls were introduced, truck owners were skeptical about them. To demonstrate their worth, Scott, in 1917, helped to organize the Wingfoot Express line that made regular runs from Akron, Ohio, to Boston, Mass., carrying tires to the company's branch there and bringing back tire fabric. He headed the first caravan to make the run, which required 24 days, but proved the dependability of the tires. Scott was reputed to possess an uncanny knowledge of weights of tires required to serve trucks of varying sizes, and this was used to advantage by the company's tire designers.

* * *

**Pneumatic Grain Conveying**

The British Electrical & Allied Industries Research Association has been investigating the practicability of conveying grain with air mainly on a small scale in rural areas. *The Engineer*, of London, comments on its report partly as follows: "It seems clear that small-scale pneumatic conveying has not been developed to any great extent, although the introduction of the combine harvester in this country in large numbers in recent years has resulted in several firms realizing its possibilities. Although quite a number of grain-conveying plants have been installed, their design does not seem to have been based on definite scientific knowledge or on extensive preliminary researches. Consequently, although these plants seem to work satisfactorily, they are by no means efficient. It is felt that much research has yet to be carried out before the most efficient system can be designed and adapted to general farm use."

* * *

**Jet Driven Ships**

Maritime authorities both in Great Britain and the United States have disclosed that they are constructing ships to be propelled by gas-turbine power plants. The latter will be generally similar to but larger than those built for jet-driven airplanes during the war. Air is sucked in, compressed, and heated. In planes, it is then ejected through tail jets to push the craft through space. On shipboard, it will be directed against the blades of turbines which, in turn, will transmit the power to propellers. The American vessel, a 10,000-ton collier, was designed by engineers of the Maritime Commission and is expected to operate along the Atlantic Coast. The gas turbine will develop from 2000 to 3500 hp. The British ship will have a 6000-hp. plant.

* * *

**Moving Post Offices**

Railway post offices in which mail is sorted as it travels have been in use for many years. Now the same idea has been extended to highways and air lanes. On October 1, which was the fiftieth anniversary of the inauguration of rural free delivery, a truck outfitted for mail sorting began regular runs over 182 miles of road between Mobile, Ala., and Union, Miss. A few days earlier the first "flying post office" took off from Washington for Chicago and Detroit. Time saving is the motive behind both innovations.

* * *

**Snow Removal Costly**

Thirty-six states spend nearly $30,000,000 annually to remove snow from highways. How much more cities spend is unkown. States in the snow belt use 50,000 units of equipment in clearing snow from 289,000 miles of traffic lanes. Aside from this expenditure, roadbuilding agencies lose much revenue by the falling off in gasoline taxes in winter. In Minnesota, where snow is heavy, driving drops 60 percent during that season of the year. Snow removal is vital to the maintenance of transportation in all localities, but especially so in the case of 54,000 communities in the nation that have no railroad connections and must depend solely upon highways.

* * *

**Plastic Plane Wings**

A laminated, glass fiber-plastic airplane wing that presents an absolutely smooth, glasslike surface has been developed by Army aircraft engineers at Wright Field, Dayton, Ohio. Sandwich-type construction is used, with cellular cellulose acetate—a lighter-than-cork material—bonded between layers of glass-reinforced laminates. The wing interior is free of obstructions such as the customary ribs and other braces, and is said to represent the first radical change in design since metal wings appeared. It is expected to aid high-speed flying through the smoothness of its surface, since the slightest scratch or projection can set up violent turbulence when the verge of supersonic flight is reached.

## Copper Company Executive Got Start Through Athletic Ability

EDWARD S. McGLONE has been made vice-president of the Anaconda Copper Mining Company in charge of western operations. He succeeds D. M. Kelly, a veteran Anaconda executive who resigned because of ill health. Mr. McGlone becomes one of the nation's youngest mine administrators and his duties include the direction of Anaconda's extensive activities at Butte, Mont., where he began his career 22 years ago. It is recalled that he got his start in mining largely because he was a good athlete.

At the Colorado School of Mines "Big Ed" McGlone was an outstanding baseball and football player. Upon being graduated in 1923 he declined an appointment to the U. S. Military Academy at West Point to follow his chosen profession of mining engineering. While seeking a starting job, the Colorado-Pittsmont team of the Butte Mines Baseball League happened to be looking for good players. As a natural consequence young McGlone went to work in the Davis Daly Mining Company's engineering department in Butte and played ball evenings. He soon became popular with the fans, and continued to play for several years. The Butte mines also had a football league, and it was in it that McGlone shone to greatest advantage. His gridiron exploits won the acclaim of the crowds, and before long he was one of the best-known men in Butte. After his playing days were over he coached one of the league's teams for a number of years.

Meanwhile, he was making equally rapid progress in the mining field. Anaconda acquired the Davis Daly organization in 1924 and shifted McGlone to an underground job as a miner and sampler on the Tramway property and then in the Anaconda Mine. He became a shift boss in the Tramway in 1925, assistant foreman in 1926, and foreman in 1929. In 1936 he was appointed acting assistant general superintendent of the Tramway and Leonard mines and next became assistant general superintendent of four of the Anaconda properties. On January 1, 1940, he was advanced to general superintendent of mines and in 1943 to general manager of mining and metallurgical operations for Montana and Idaho. In July, 1945, he was promoted to the post of general manager of all Anaconda's western mining and metallurgical operations.

EDWARD S. McGLONE

Mr. Kelly's resignation terminated 31 years of active service with Anaconda, but he will remain on the staff as a consultant to the legal and operating departments. He originally joined the company's legal staff on June 1, 1915, when he resigned as attorney general of Montana. He was made western general counsel in 1931 and became vice-president in charge of western operations in 1936, succeeding J. R. Hobbins, now president of Anaconda. Under his direction, western mines of the company produced monthly during the critical war period millions of pounds of copper and other strategic metals.

Mr. Kelly migrated to Montana from Iowa when 22 years old and taught school to earn money with which he studied law. He started practicing in 1905 at Whitehall, Mont., became county attorney the following year, and was elected attorney general in 1912.

## Materials Engineering in Certain German Industries

THERE are radical differences between American and German practices in selecting and applying materials in the pump, compressor, and rock-drill industries, according to B. F. Shepherd, chief metallurgist at the Phillipsburg, N. J., plant of Ingersoll-Rand Company. His observations are based on visits to 27 German factories under the auspices of the Office of Military Government for Germany and have been published by that United States agency as Fiat Final Report 530.

Mr. Shepherd found that less than half of the concerns investigated have any sort of materials control, while the others depend more or less upon the individuals in control, and the system is personalized and secret.

"Responsibility for the proper materials centers largely in the metallurgists of the suppliers and the use of DIN (Deutsch Industrie Normal) materials," the report states. "The consumer in many cases does not know what the material is, chemically or physically, and is satisfied to rely upon the supplier, not only for the suitability of the material to the service but also for the maintenance of quality. Specifications originated by plants are rare. The DIN number is usually marked on the drawing. Materials lists of a complete machine are generally not available. Purchase orders referring to materials by brand names or specifying 'same as ordered before' are common."

Mr. Shepherd found design more stressed than materials. "When parts fail, change in design receives first attention; change in materials comes later." Part of the difficulty during the war was undoubtedly the scarcity of proved materials, for the report says, "Time and again the statement was made that the problem was not to find something new, but how to alter design so that an ersatz material would operate satisfactorily." It is easier to change designs there than it would be here, it is explained, because smaller quantities are produced and the manufacturing set-up lends itself more readily to such a procedure.

That some German practices are influenced by the comparatively low cost of labor is indicated by the comment: "In several cases, considerable labor was spent to reduce the danger of fatigue failure, i. e., polishing surfaces, breaking corners of edges, machining to distribute stress, many of which operations would be introduced in the United States with extreme reluctance because of the high labor costs involved."

As might be expected from the foregoing, it was discovered that alloys are used much more sparingly there than in the United States. Cast iron is rarely alloyed, and does not serve under temperature and pressure conditions common to it in this country. Welded structures such as frames and bases are employed only in isolated cases. Heat-treating facilities are described as generally poor, judged by American standards. Atmosphere control of hardening furnaces as practiced here was not found. "Written detailed heat-treatment instructions are rare. Time and again the shop route card was found to read 'harden,' or parts were sent to the heat-treating department as a matter of routine. The foreman was supposed to do the job correctly 'because he had been doing it for a long time.'"

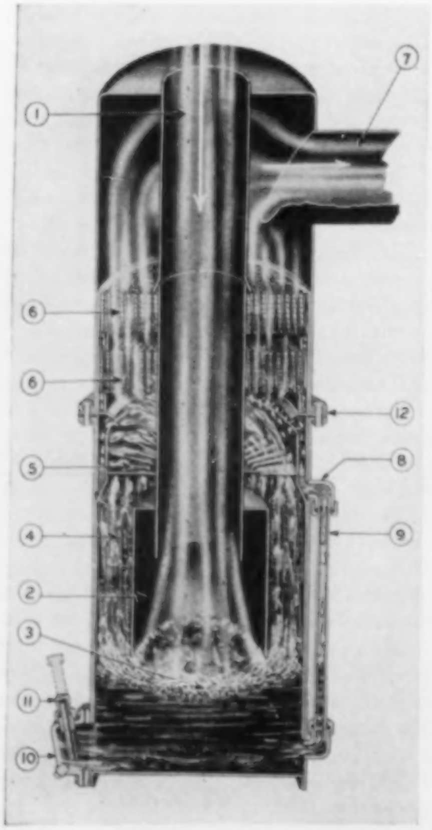
Illustrating the relative status of the tool-steel industry as applied to the branches of manufacturing discussed, the report mentions a semisecret hardenability test by which one German rock-drill maker selects steel for pistons. "Only 20 to 30 percent of the heats submitted pass the test," it is stated. "A more sensitive test that is used in the United States was described in the industrial literature more than 20 years ago, and more than 95 percent of the heats made by our steel mills are acceptable."

The report concludes with the observation that, while "much excellent metallurgical work has been done by German scientists and many first-grade technical papers have been published, there is a vast gap between this knowledge and its application to commercial practice. Materials engineering in Germany is for the top-bracket engineers only. There is no attempt to instruct the 'man at the fire' as to why he performs his alloted tasks. As a result, operations are carried out methodically, with no individual initiative or raising of the level of understanding as we know it in the United States. Many German metallurgists agreed that this is true, but inasmuch as it is a part of the general German philosophy, they were at a loss to know what to do about it."

## New Oil-Bath Air Cleaner and Silencer

SIX important features are claimed by Continental Air Filters, Inc., for its new Whirlwind oil-bath air cleaner and silencer for air compressors and diesel and gas engines. Among these are visual oil circulation to determine whether unit is functioning properly; adjustable oil level that permits cleaner to handle a considerable range of air volumes; and easily demountable construction for inspection or repair. In its passage through the unit, the air flows down through a central tube and an expansion chamber into an oil reservoir. There it impinges against the oil, which traps the heavier dust particles. Picking up oil, the air moves upward through an 8-inch thickness of crimped, coarse-mesh hardware cloth, where it undergoes thorough scrubbing. Then the oil is thrown out of the air stream by centrifugal action imparted to it by stationary "whirling vanes" above the wire mesh. Continuing upward, the air flows through filter cells, which remove any remaining traces of dust and oil. The clean air passes out of the unit by a side outlet, while the oil returns to the reservoir by way of the gauge glass.

The Whirlwind needs little servicing because the lower section is washed continually by the circulating oil. The latter can be drained from the reservoir through a bottom opening, and removal of a clean-out plate permits scraping out accumulated sludge. The filter is available in five sizes with capacities ranging from 600 to 6500 cfm.



FLOW CYCLE AND FEATURES

1- Air-inlet tube; 2- expansion chamber; 3- oil reservoir; 4- mesh hardware cloth; 5- stationary vanes; 6- filter cells; 7- air outlet; 8- oil return to reservoir; 9- gauge glass; 10- removable clean-out plate; 11- oil-level regulator; 12- demounting bolt. The air-intake tube can be extended to any desired height to avoid the heaviest dust concentrations at ground level, and as most pipe connections between engines and compressors are horizontal or rise vertically from floor level, side air discharge facilitates installation by eliminating or reducing the number of elbows.

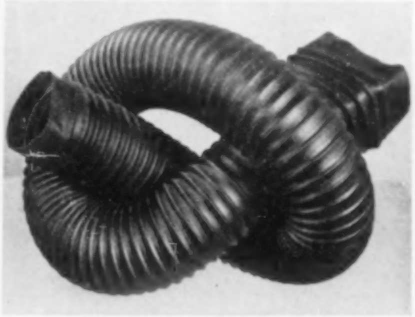
# Industrial Notes

It is hard to grasp, but we are told that scientists have created a device that can gauge vacuum pressures as low as one one-hundred billionth of a pound per square inch. The purpose of the supersensitive instrument is to increase the efficiency and life of television, radio, and other electronic tubes.

Announcement has been made by the Bee Chemical Company of a new brass corrosion inhibitor that is being marketed under the trade name Brass Lyfe. It is miscible with oils and lacquers and, so admixed, is said to arrest corrosion of copper-containing alloys regardless of whether it is induced by oxygen, organic acids, or amines.

Instead of being packed in paper containers, as is now the practice, frozen fruits and vegetables from one processor will reach the kitchen in tins. The reason for this change in packaging is that cans can be vacuum-sealed, thus providing absolute protection against change in flavor and oxidation, which causes fruit to turn black. The plan is to use square instead of the conventional cylindrical containers in order to save shipping and storage space.

Industrial type hose and accessories for ventilating purposes and fume and dust control are being manufactured by the American Ventilating Hose Company by a new process. Using Neoprene-coated fabrics and spiral-wire reinforcing, it turns out hose in continuous lengths and of any diameter from 1 to 24 inches, as well as of varying physical characteristics such as flexibility, compressibility, and crushing resistance to meet service requirements. Cuffs, bushes, reducers, or flanges may be permanently attached to facilitate connection to outlets of different sizes or shapes. Hose is lightweight and is known as the Continuous Wind type.



OVER-ALL PROTECTION

This new American Optical Company face shield and headgear is of extra-large proportions to give complete protection against flying particles and splashing acids, oils, alkalies, hot water, etc. The window is made from cellulose acetate 0.04 inch thick and is securely held in "on" or "off" position by positive friction joints. The fiber head covering is built for comfort, has a leather sweatband in front, and can be easily adjusted to fit any head size.

Combustible gas has been produced from commercial atomic C uranium for more than half a year, according to a recent news announcement. This information in itself is not startling; but the statement that the gas is eventually expected to drive a locomotive across the United States from coast to coast at a cost of one dollar is hard for the lay mind to comprehend.

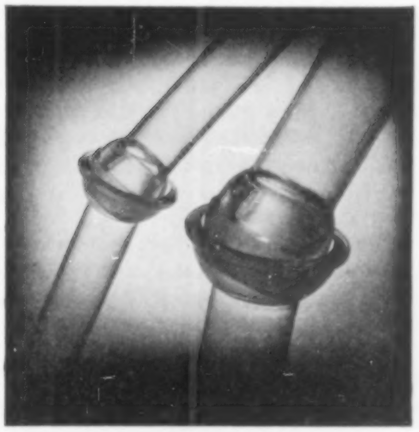
Adaptability characterizes the sandblasting machine recently announced by Leiman Bros., Inc. The unit has armholes with protective cuffs in the loading door for handling large pieces individually and a removable, rotating, motor-driven basket for cleaning small articles such as bolts, nuts, etc. It operates on the closed system, the sand being fed to the nozzle from a magazine and returned to it by gravity flow for reuse.

An attachment called a screw finder has been designed by James Industries, Inc., for use in connection with electric or pneumatic screw drivers. It is said to start, set, and hold a screw firmly, to be operative in places not easily accessible to other tools or fingers, and to leave no impression on screw head or work surrounding screw. It is of the collet type, nonrotating, and available for all standard types and sizes of machine and wood screws.

So that a motorist with a punctured tire can continue driving with impunity, the United States Rubber Company is manufacturing an inner tube with a succession of wafflelike pockets. The purpose of the indentations is to provide surplus rubber which, in case of damage, has a tendency to crowd around the hole and to slow up deflation. Royal Air Guard is the name under which the tube is to be marketed.

A new market has been created for light-gauge aluminum because the paper disk now generally used to seal milk bottles is outlawed in many communities by the Board of Health. The closure leaves the lip of the container unprotected and exposed to contamination. Caps covering the tops completely are required, and aluminum has been found to be suitable for the purpose. Being more plentiful than paper at the present time, such hoods will actually cost $1 less per 1000 bottles than the conventional seal.

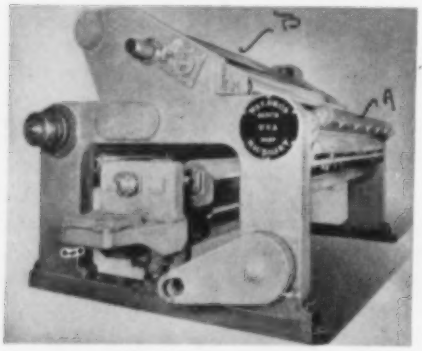
Static electricity as it relates to belts operating in dust-laden atmospheres is a menace that can be controlled, it is said, by a coating offered by Acheson Colloids Corporation. It is a mixture of quick-drying solvents in which colloidal graphite is carried in suspension. Thinned with carbon tetrachloride, the liquid is applied with a carbon brush that serves as a contact between the charged belt and ground, while the film acts as a conductor between the belt and brush, thus completing the circuit.



GLASS KNEES

These ball-and-socket joints are a Pyrex-brand product for the use of the laboratory where it is often necessary to make complicated arrangements of flasks, jars, and tubing that are later taken apart for other tests requiring different set-ups. The jointed tubing simplifies this work of assembly and disassembly and also permits slight movement of the apparatus without causing leaks or breakage. Before it leaves the factory, each is checked for accuracy and undergoes a severe vacuum leakage test in the dry state. The ball-and-socket joints come in various sizes and are precision ground for interchangeability.

Patents are pending on a high-speed coating machine which is described as a new development in the paper and textile converting field. Named the Microjet, it is manufactured by the John Waldron Corporation and is said to be suitable for making fine paper for printing and other purposes, as well as photographic paper and film, fabrics, etc. Full details about the equipment are not yet available, but the operating cycle is as follows: As a web of paper, for example, enters the machine, it passes over a roll which applies a liquid coating to the surface in excess of the amount required. This surplus material is next planed off by a high-velocity air blade that emerges from the member indicated by the letter "A" in the accompanying illustration. Continuing in its travel, the web goes over suction apron "B" and thence into a single-pass air drier. Issuing from the latter, it is ready to be wound in rolls. The tension on the paper during its progress is controlled either by an electric eye or pneumatic means, and an air hoist is used to lift the heavy unfinished rolls into position for passage through the machine. It is claimed that the Microjet can handle widths ranging from 20 to 220 inches at speeds up to 1000 feet a minute, can apply light- or heavy-weight coatings, and is fully automatic in its action.



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Brown Instrument Company has introduced a portable thermocouple suitable for quickly measuring the temperature of molten aluminum and other low-melting-point metals such as lead, zinc, and babbit. The device is immersed several inches below the surface of the processing bath and held there usually for ten to twelve seconds to obtain a steady reading. It is claimed that the latter is not affected by thermocouple-wire conditions and that parasitic-current generation is absent at the hot junction. Any metal adhering to the instrument upon withdrawal is removed by shaking it.

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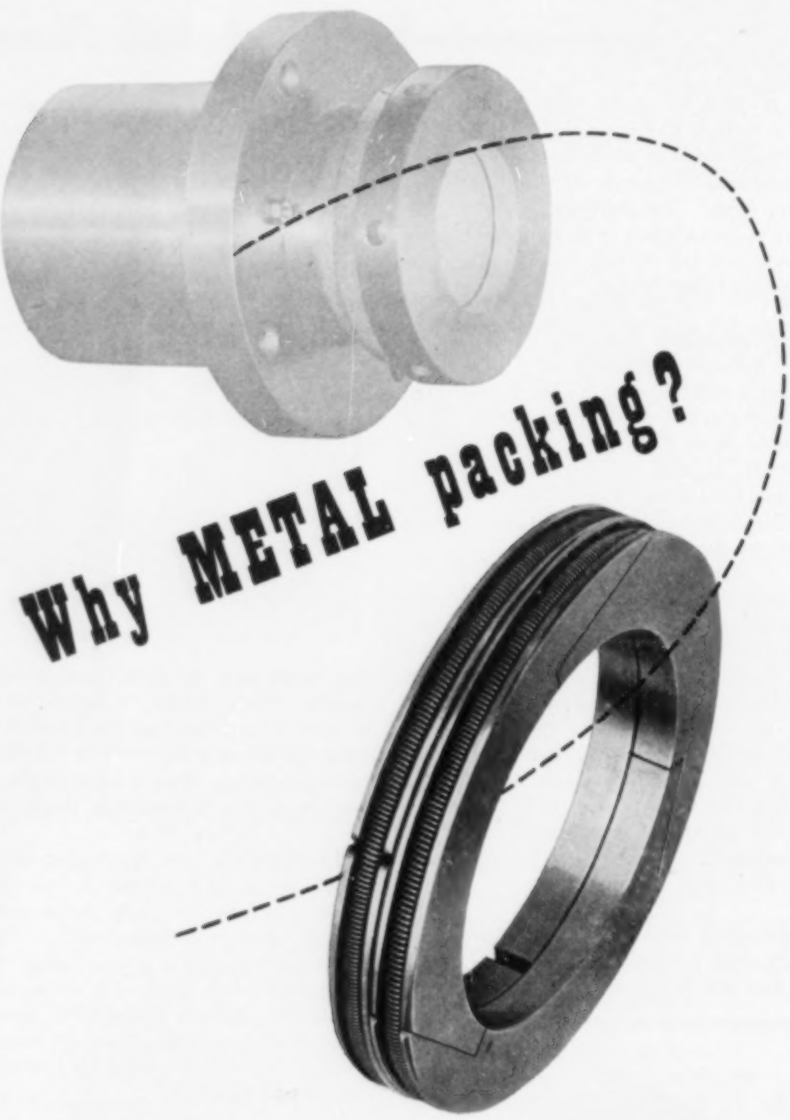
In place of the time-honored salamander, Herman Nelson Corporation is offering a gasoline-burning unit for heating spaces in temporary structures or buildings under construction, for thawing frozen areas and machinery, and for curing materials


Why METAL packing?

France Metal Packing creates very slight friction because it rides on the rod as a lubricated metal to metal contact. Why use materials that are known to develop high friction? Where operating conditions call for a non-metallic packing, France furnishes either carbon or carbon bakelite rings—both especially developed for the low co-efficient of friction. The special materials and fine workmanship applied to the outstanding France Packing designs result in long packing life and negligible maintenance effort.

*Convert to France Metal Packing for . . .*

**Less maintenance time**
**Lower maintenance costs**

FRANCE
PACKING COMPANY
PHILADELPHIA 35, PA.

REPRESENTATIVES IN
PRINCIPAL CITIES

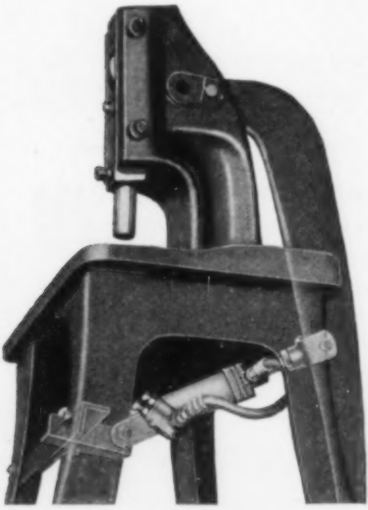
such as plaster, paint, and concrete. The stove, which has an inclosed gravity-fed combustion chamber and a finned heat exchanger, has an output of 190,000 to 250,000 Btu. an hour. The heated air is delivered to the desired places by collapsible ducts, and ventilating air is directed across the outer surface of the heat exchanger by a high-capacity axial fan operated by a small gasoline engine or electric motor. The ducts are strapped on top of the portable when it is not in service and are flame- and heat-resistant. They are 24 feet long and 12 inches in diameter.

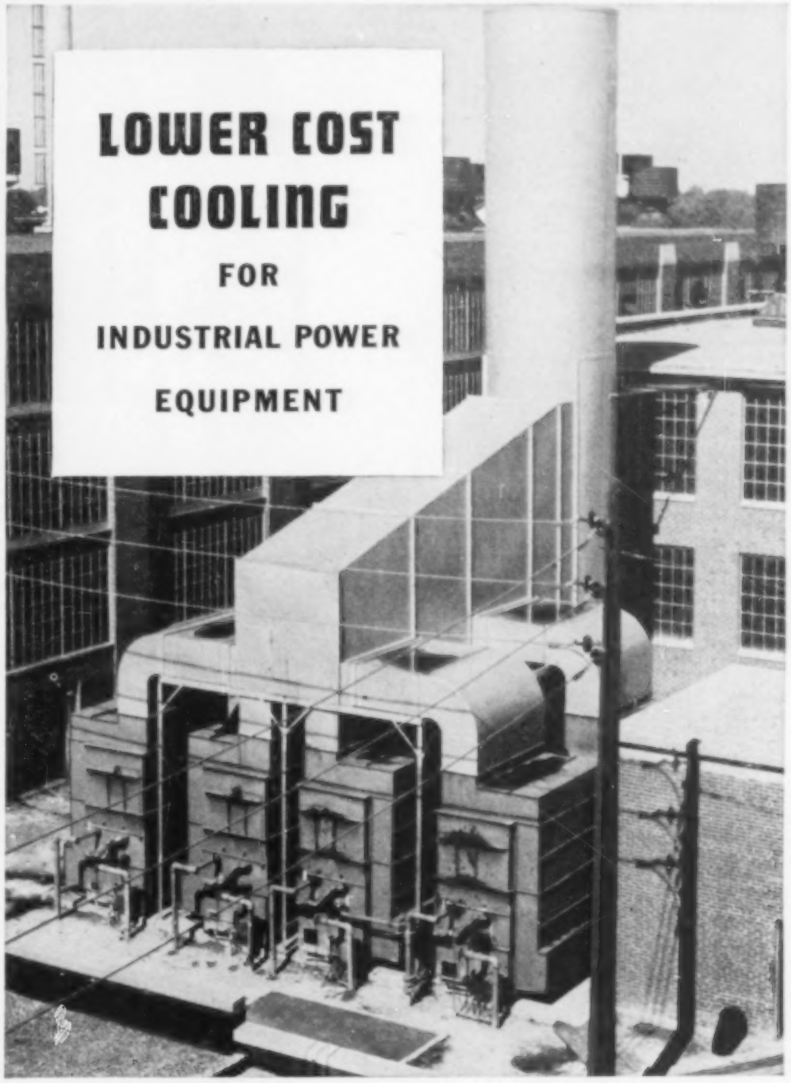
---

A filter, pressure regulator, and pressure gauge, all mounted on a panel for easy installation, compose the Willard C. Beach "Sta-Dri" for conditioning compressed air used to operate spray guns, pneumatic tools, etc. Its purpose is to protect the tools and improve their performance by removing dirt, scale, moisture, and oil from the air and regulating its pressure for the most efficient service. The unit is made in two sizes with respective capacities of 30 and 65 cubic feet of air per minute at 100 pounds pressure. It is manufactured by Beach Precision Parts Company, 120 Mechanic Street, Boonton, N. J.

---

Among the new products announced by The National Pneumatic Company is a packaged unit that converts any kick press into an air-operated press. The kit is easily installed by a mechanic and consists mainly of a pneumatic cylinder mounted on a pivot-type bracket that is attached to the press lever. Cylinder has a power rating of 270 pounds with air at 100 pounds pressure, and speed of piston strokes is adjustable. Standard unit is controlled by a foot valve that may be replaced by valves designed for 2-hand or safety control. It is claimed that changeover from manual to power operation results in increased production and, because of the uniformity of the stroke, in work of improved quality.





NIAGARA AERO HEAT EXCHANGERS provide a closed system of re-circulated clean jacket water at controlled temperatures and without the consumption of cooling water except for the small amount which is evaporated. Heat is absorbed at the rate of 1000 BTU per pound of water evaporated.

Ample cooling capacity is available in compact, economical equipment. There are additional savings in the cost of piping and pumping.

The operating dependability of NIAGARA AERO HEAT EXCHANGERS is assured by their record of long years of service under the most difficult industrial conditions. Ask for Bulletin 96-CA.

**NIAGARA BLOWER COMPANY**
*Over 30 Years of Service in Industrial Air Engineering*
405 LEXINGTON AVE., NEW YORK 17, N.Y.
*Field Engineering Offices in Principal Cities*

INDUSTRIAL COOLING • HEATING • DRYING
NIAGARA
HUMIDIFYING • AIR ENGINEERING EQUIPMENT

### Industrial Literature

An illustrated folder, *Industrial Packing,* issued by France Packing Company, 6512 State Road, Philadelphia 35, Pa., describes various types of metal packing.

The nature and uses of electrical remote indicating and control systems are discussed in a 12-page engineering bulletin, No. 14B6641, published by Allis-Chalmers Manufacturing Company, Milwaukee 1, Wis. Among their numerous applications is that of controlling gas and air valves.

*Pneumatic Control Valves and Controller Accessories* is the title of a new 35-page bulletin issued by The Foxboro Company, Foxboro, Mass. It is a complete revision of a previous publication and also contains much additional material.

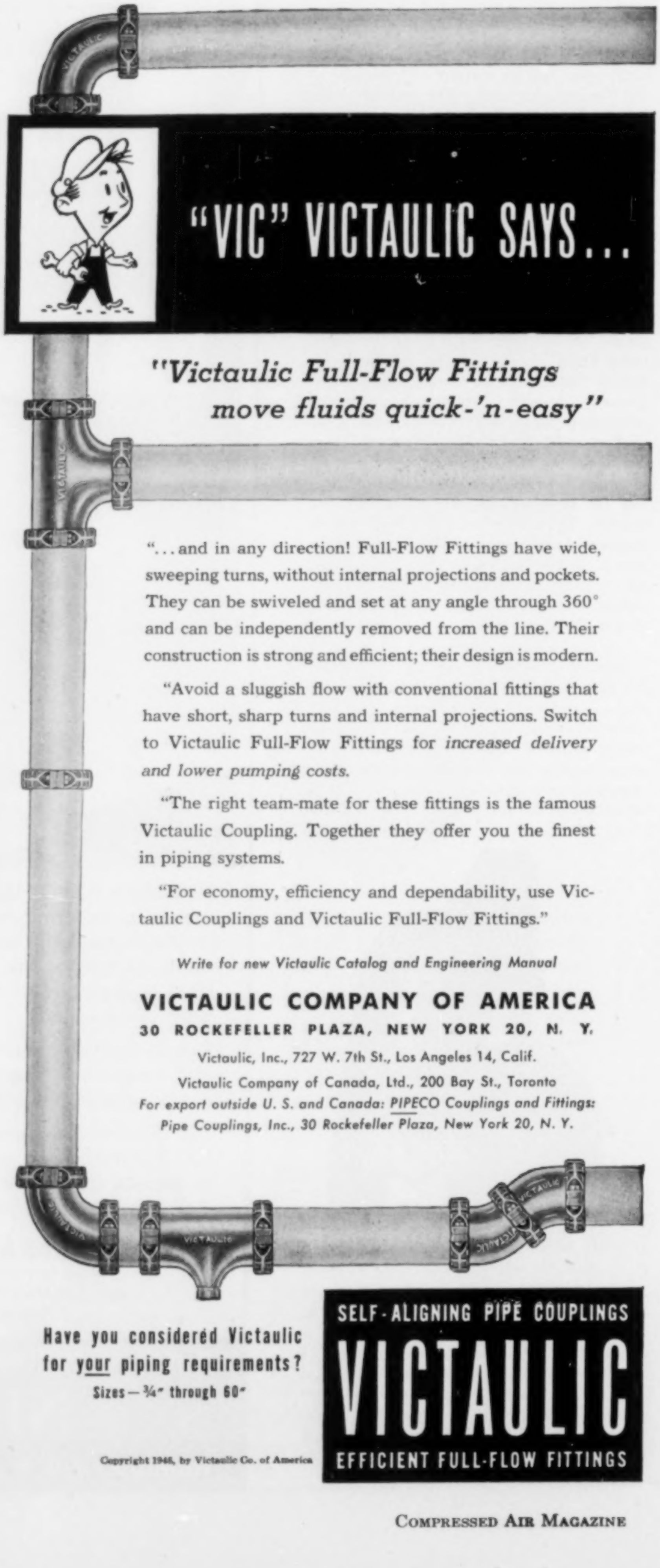
A *Hose Coupling Handbook* has been issued by Hose Accessories Company, Lehigh Avenue at 17th Street, Philadelphia 32, Pa., to aid users in selecting and applying couplings. It lists and describes various types and illustrates "right" and "wrong" methods of handling in service.

Thousands of operations involving pulling, pushing, or lifting are being performed by air cylinders, whose applications are continually being extended through engineering ingenuity. These pneumatic devices speed up production, reduce costs, and, by eliminating physical effort, make for more contented workers and fewer shop accidents. Information and examples as to how such cylinders are being used are given in a new bulletin, *Bellows Air Motors,* issued by Bellows Senacon Company, 798 N. Main Street, Akron 10, Ohio.

Every contractor has compressed air on the job and it is only natural that new air-driven tools should be developed continually to expedite the diversified operations involved. To make it easy for contractors to acquaint themselves with the numerous air tools that are available for their work, Ingersoll-Rand Company has issued a special catalogue covering those it makes. It is designated as Form 5600 and can be obtained from the company's principal office at 11 Broadway, New York 4, N. Y., or from any of its branch sales offices in different parts of the country.

To learn first hand what consumers think of preformed wire rope, the ten manufacturers of that product in this country sent a pamphlet containing ten questions to their customers. Copies were tied to coils of rope shipped from their factories, were inclosed with invoices and general correspondence, and distributed in other ways. Replies were received from 8339 users, and these have been tabulated in a booklet that is obtainable from the Preformed Wire Rope Information Bureau, 520 N. Michigan Ave., Chicago 11, Ill.

A booklet that gives complete data on the properties, fabrication, and application of U.S.S. Cor-Ten has been issued by United States Steel Corporation Subsidiaries, 429 Fourth Avenue, Pittsburgh 19, Pa. The metal is described as "a tonnage grade of steel possessing relatively high strength and superior resistance to atmospheric corrosion, combined with good workability, weldability, and resistance to abrasion, impact, and fatigue—all at low cost." Its chief application is in fields where it is desirable to keep weight low and still provide protection against atmospheric corrosion. Favored for use in mobile units such as railroad cars, trucks, trailers, and buses, mine cars, as well as materials-handling and marine equipment.



"VIC" VICTAULIC SAYS...

*"Victaulic Full-Flow Fittings move fluids quick-'n-easy"*

"...and in any direction! Full-Flow Fittings have wide, sweeping turns, without internal projections and pockets. They can be swiveled and set at any angle through 360° and can be independently removed from the line. Their construction is strong and efficient; their design is modern.

"Avoid a sluggish flow with conventional fittings that have short, sharp turns and internal projections. Switch to Victaulic Full-Flow Fittings for *increased delivery and lower pumping costs.*

"The right team-mate for these fittings is the famous Victaulic Coupling. Together they offer you the finest in piping systems.

"For economy, efficiency and dependability, use Victaulic Couplings and Victaulic Full-Flow Fittings."

*Write for new Victaulic Catalog and Engineering Manual*

**VICTAULIC COMPANY OF AMERICA**
**30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.**
Victaulic, Inc., 727 W. 7th St., Los Angeles 14, Calif.
Victaulic Company of Canada, Ltd., 200 Bay St., Toronto
*For export outside U. S. and Canada: PIPECO Couplings and Fittings: Pipe Couplings, Inc., 30 Rockefeller Plaza, New York 20, N. Y.*

**Have you considered Victaulic for your piping requirements?**
**Sizes—¾" through 60"**

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SELF-ALIGNING PIPE COUPLINGS
VICTAULIC
EFFICIENT FULL-FLOW FITTINGS

*A development of*
**B.F. Goodrich**
**FIRST IN RUBBER**

Photo courtesy U. S. Bureau of Reclamation

# That's no place for a tool to strangle

*A typical example of B. F. Goodrich improvement in rubber*

THEY'RE drilling holes for dynamite charges, to blast out rock for a dam. It's no cinch to lug a heavy air hammer up that cliff. Too many times it had to be promptly carried down again — the tool had choked to death.

Oil in the compressor sprayed out into the air hose. Oil destroys rubber. Particles of rubber came loose, flew up into the air hammer, finally choked and ruined it.

B. F. Goodrich engineers who had designed and made hundreds of kinds of better hose, set out to find the answer to this problem. They worked on a new "recipe" for rubber, and by adding, subtracting, changing proportions, they finally found a rubber that would not only have high resistance to oil, would not flake off to choke tools, and yet had the flexibility needed for air hose.

Hose lined with this new rubber was made and put to work. On jobs where hose had had to be changed in weeks to save tools, this new B. F. Goodrich hose lasted months, even years. The development was just in time to save money and trouble on big jobs such as Shasta, where 57 miles of BFG hose was used.

Development work like this goes on constantly at B. F. Goodrich to improve every product. That's why you're sure of better values in rubber when you specify B. F. Goodrich to your distributor. *The B. F. Goodrich Company, Industrial Products Division, Akron, Ohio.*

**B.F. Goodrich**
RUBBER *and* SYNTHETIC *products*

# CONTRACTORS!

## **Check** *your equipment against this list.* *Get all the benefits to be had with Ingersoll-Rand AIR TOOLS.*

There are many operations where only Air Tools can do the job, but there are many, many more where AIR TOOLS are the choice because they are lighter, smaller, more powerful and easier to handle.

Write now for our new 24-page bulletin, "Air Tools for Contractors" illustrating many unusual applications and describing the advantages of Ingersoll-Rand Air Tools.

AIR TOOLS
FOR CONTRACTORS
Ingersoll-Rand

*Send for your copy*

**Air Motors**
**Chippers**
**Concrete Vibrators**
**Diggers**
**Drifters**
**Drills**
**Drill Steel Cutters**
**Grinders**
**Hoists**
**Jackhamers**
**Jackbits**
**Jackbit Grinders**
**Jackmills**
**Impact Wrenches**
**Paving Breakers**
**Pile Drivers**
**Reamers**
**Riveters**
**Rock Drills**
**Saws**
**Scalers**
**Shank Grinders**
**Sharpeners**
**Sump Pumps**
**Tampers**
**Wagon Drills**
**Wire Brushes**
**Wood-Borers**
**Wrenches**

**Ingersoll-Rand**

11 BROADWAY, NEW YORK 4, N. Y. 8-943

## WALWORTH PRESENTS

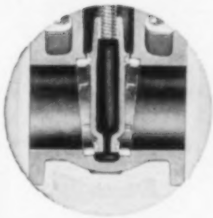
## A New Line of

# IRON BODY GATE VALVES

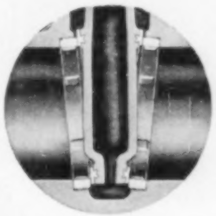
with screwed or flanged ends

6
125 WSP
200 DWG
WALWORTH
6
125 WSP
200 DWG
WALWORTH

## ... 8 Outstanding Features

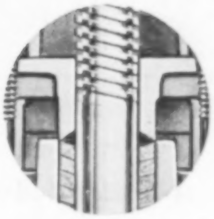


**Straight-Flow Port Design** reduces fluid turbulence to a practical minimum.

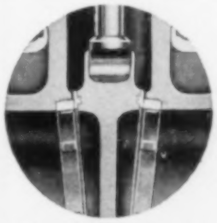


**Seat Rings** of end-seated type are screwed into the body.

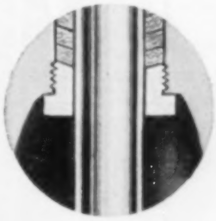
**Sure-Grip Malleable handwheel** for non-skid gripping even with heavy gloves.



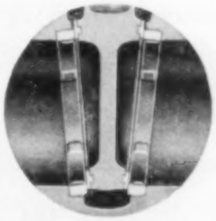
**Brass Liner on Glands** assures greater resistance to corrosion and scoring.



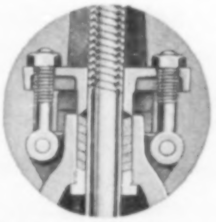
**T-head disc-to-stem connection** on OS&Y types provides stronger connection, prevents loosening of disc by corrosion.



**Bronze back-seat bushings** in bonnets of OS&Y valves.



**Solid Web Type disc** in OS&Y valves for greater strength and longer service.



**Hinged Gland Eye-Bolts** on OS&Y valves permit faster, easier repacking under full pressure.

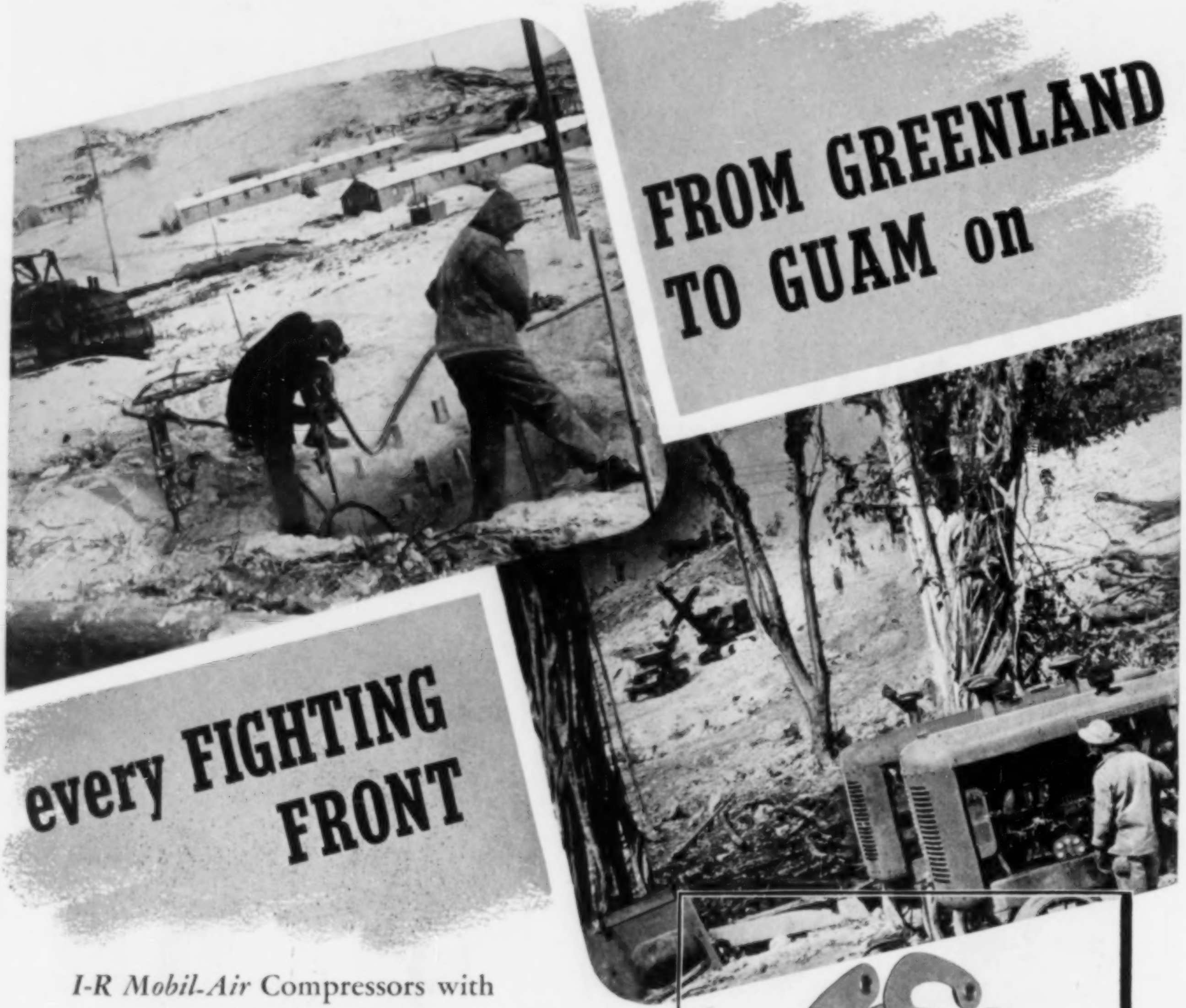
# WALWORTH

## valves and fittings

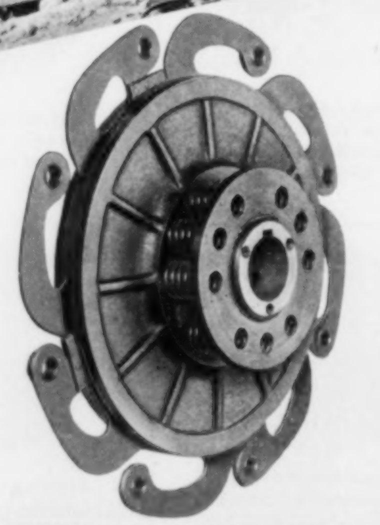
60 EAST 42nd STREET, NEW YORK 17, N. Y.

**For Complete Information** on these new Walworth Iron Body Valves, write for bulletin 106.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD



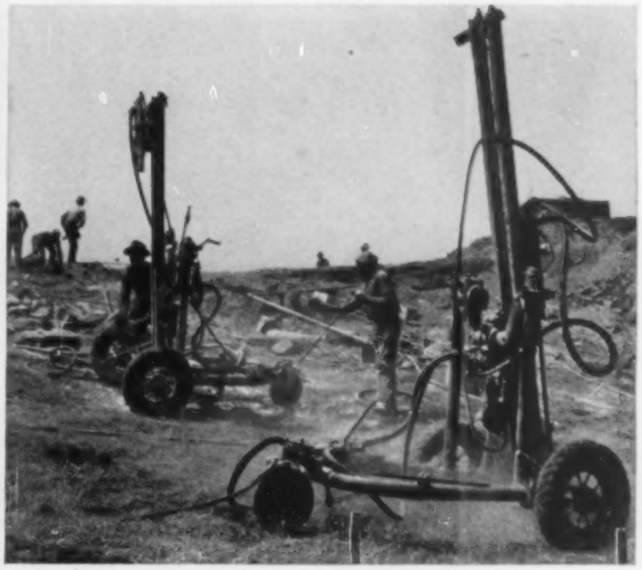
*I-R Mobil-Air* Compressors with *Flex-Disc* Clutches generated air power for jackhammers and wagon drills in construction of bases and airfields. Under conditions from extreme cold to extreme heat, these clutches give easy starting and continuous operation. Their simple construction makes for inexpensive maintenance on the job. After throwing the clutch for starting up, the boys never knew there was a clutch on any of these compressors.



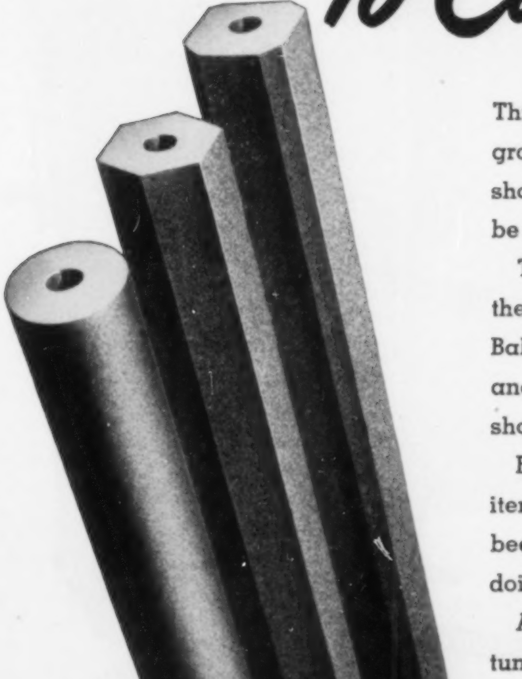
I-R Mobil-Air Compressors are equipped with dependable, low-upkeep *Flex-Disc Clutches.*

**INDUSTRIAL CLUTCH CORPORATION**

**Waukesha Wisconsin**



# Bringing Life-Giving Water to California Farmers



Three commonly-used sections of Bethlehem Hollow Drill Steel—round, hexagon, and quarter - octagon.

Through these bleak, arid channels will soon flow precious water to growers of grapes and other produce in California. The rock drilling shown here is part of a vast irrigation project which, when finished, will be of priceless value to farmers of Kings, Tulare, and Kern Counties.

This, the Friant-Kern Canal, will wind through the fertile heart of the Golden State, carrying water southward from Friant Dam to Bakersfield. In digging this giant ditch, contractors are meeting their ancient enemy, rock—tough, age-old granite that must be drilled and shot to facilitate the excavating work.

Bethlehem Hollow Drill Steel is, of course, a familiar and necessary item of equipment. Here, as on countless other jobs where rock has been cut to powder by this shock-resisting steel, Bethlehem Hollow is doing he-man's work, day after day, for some of the leading contractors.

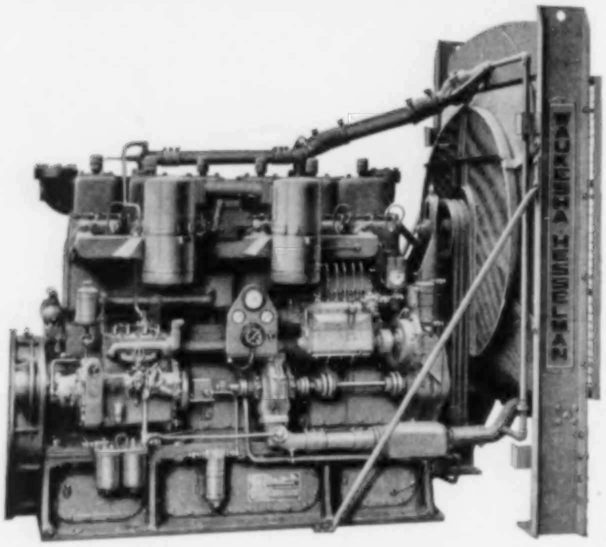
Ask for it by name whenever there's rock to be drilled—in mining, tunneling, road-building, and excavating work.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
On the Pacific Coast Bethlehem products are sold by
Bethlehem Pacific Coast Steel Corporation

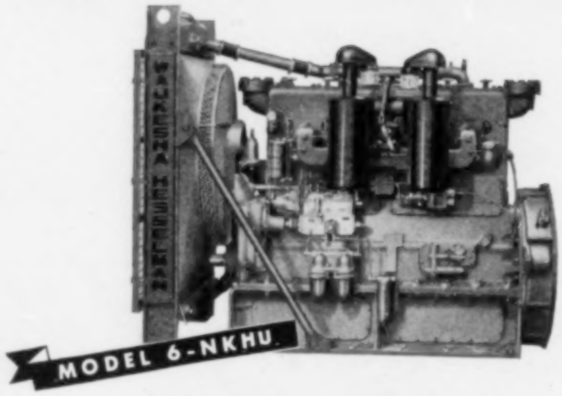
**BETHLEHEM HOLLOW DRILL STEEL**

BETHLEHEM STEEL

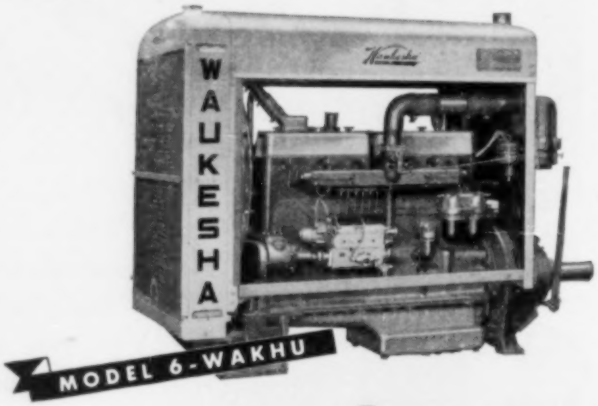
# WAUKESHA
# HESSELMAN *Oil* ENGINES



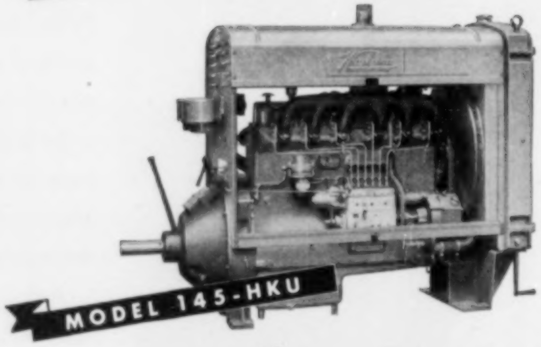
**MODEL 6-LRHU**



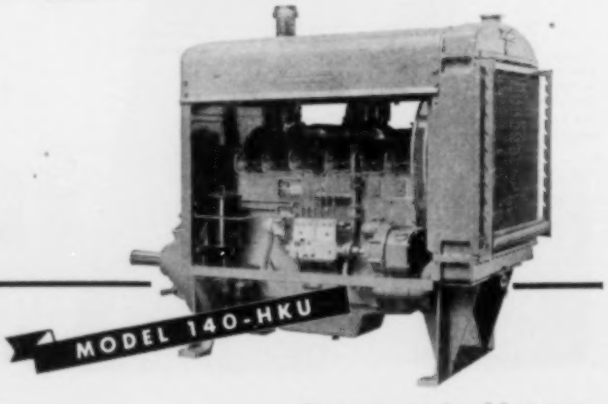
MODEL 6-NKHU



MODEL 6-WAKHU



MODEL 145-HKU



MODEL 140-HKU

Ingersoll-Rand Portable Compressors with Waukesha-Hesselman power have proved to contractors all over the world the advantages of these oil engines:

**1—Burns safety diesel fuels**, distillates, domestic furnace oils Nos. 1, 2 or 3.

**2—Starts with Electric Starters** . . . even the big 300 hp. engine . . . in coldest weather. Press the button—and it's under way.

**3—Should Gasoline or Butane** be the preferred fuel, it may be *converted*—without change of pistons, rods, cylinder heads or any internal part.

**4—Electric Spark** provides positively timed ignition—eliminates need for high compression to fire diesel fuel. The result is longer life, less wear, lighter weight. Moving parts last longer, cost less for replacement.

**5—Lower Compression and Explosion** pressures remove destructive torque reversals from the driven machine and reduce upkeep.

**6—Lower Pressures** make lighter flywheels and other moving parts possible; improve performance by giving quicker pick-up, higher speed, increased output. A Hesselman is even livelier than a gasoline engine of the same size.

**7—Waukesha-patented** non-sticking piston rings make the Hesselman an all-season, no shut-down power unit.

*For all your engine needs, consult Waukesha now. Get Bulletin 1200.*

| Power Unit Model | No. of Cyls. | Bore and Stroke, In. | Displ. Cu. In. | Speed RPM |
|---|---|---|---|---|
| *130-HLU | 4 | 4 x 5 | 251 | 800-2000 |
| *VRZHU | 4 | 4⅝ x 5¼ | 353 | 800-1600 |
| *140-HKU | 6 | 4½ x 5½ | 525 | 800-1800 |
| *145-HKU | 6 | 5¼ x 6 | 779 | 800-1800 |
| 6-WAKHU | 6 | 6¼ x 6½ | 1197 | 800-1600 |
| 6-NKHU | 6 | 7 x 8½ | 1962 | 600-1050 |
| 6-LRHU | 6 | 8½ x 8½ | 2894 | 600-1050 |

*These Hesselman Engines can be converted to burn butane or gasoline, with no internal changes. The others can also be converted without internal changes, provided manifolds and accessories for carbureted fuels are applied.

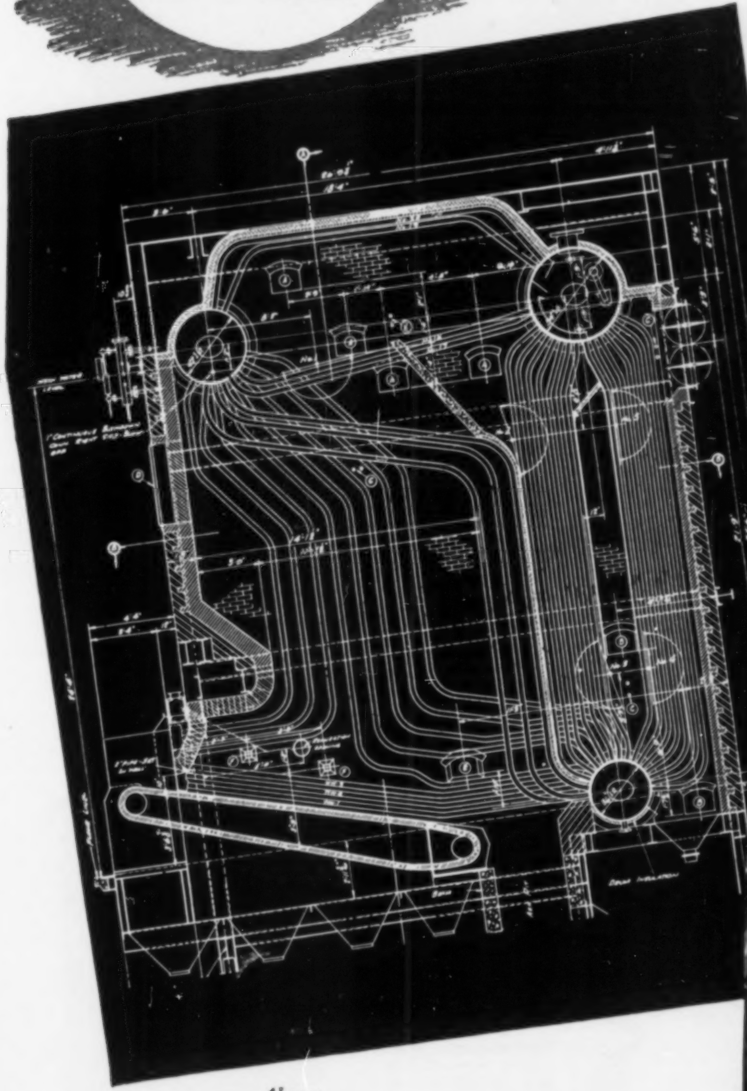
**WAUKESHA MOTOR COMPANY, WAUKESHA, WIS.**

**NEW YORK . TULSA . LOS ANGELES**

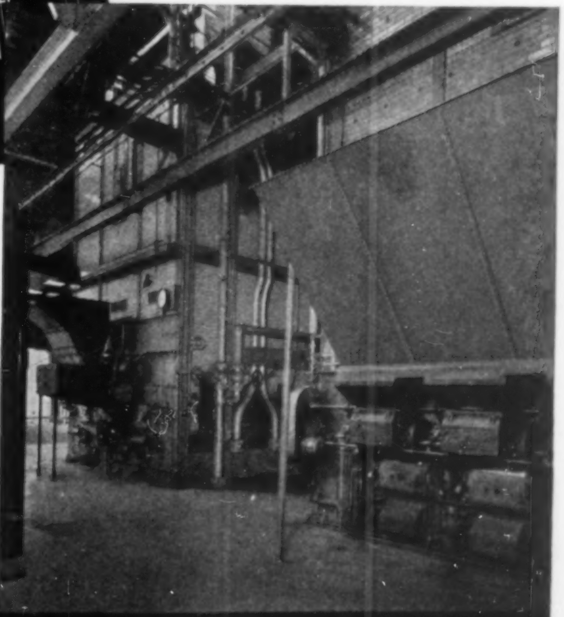
CLASS VL Vogt

# Steam Generating Units

## *for* POWER *or* PROCESSING LOADS, *and* HEATING



The design provides large furnace volume and a high ratio of radiant heating surface. Proper combustion is assured with any fuel or method of firing. Superheaters, air preheaters, economizers, water walls, and soot blowers can be readily incorporated. Vogt Class VL Steam generating units are giving satisfactory service in Hotels, Sugar Refineries, Steel Mills, Furniture Factories, Distilleries, Oil Refineries, and related industries. A bulletin showing typical installations will be sent upon request.

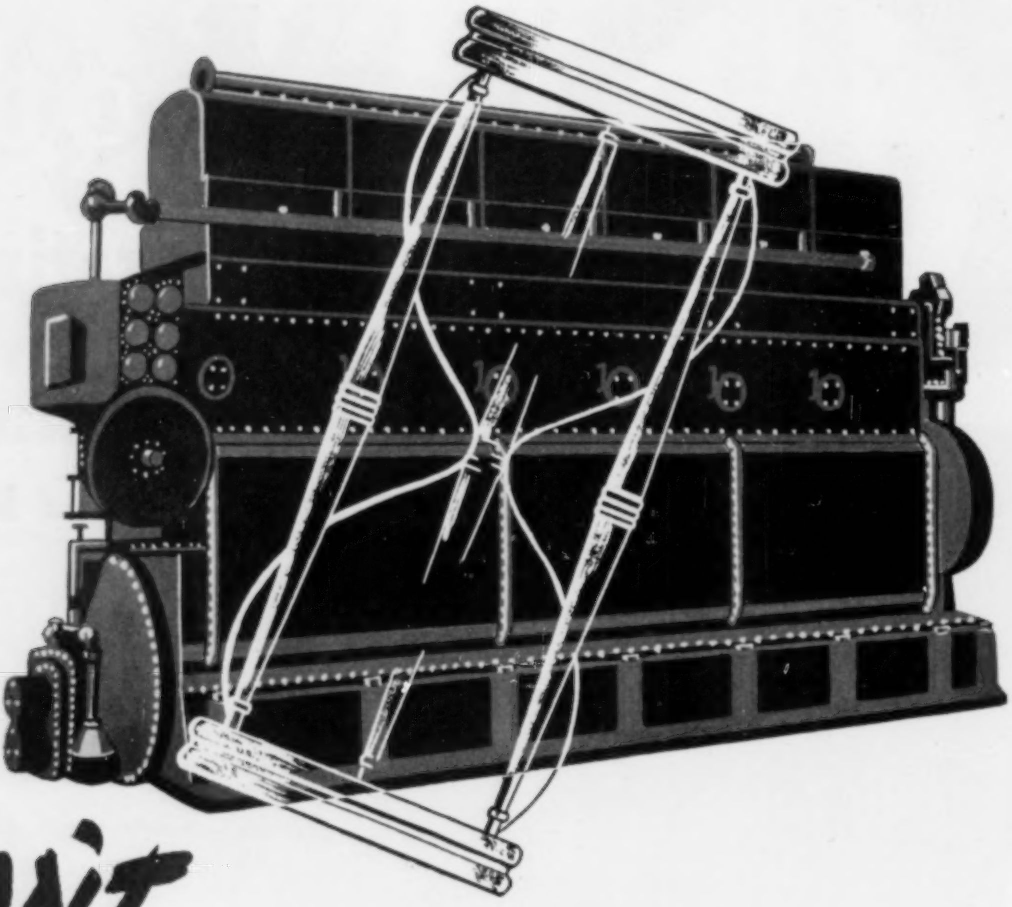


*Above:*
This 90,000 lbs. steam per hour unit, designed for 475 lbs. pressure, serves the Mansfield Tire & Rubber Co., Mansfield, Ohio.

Vogt
FOR BETTER BOILERS

*Right:*
Two 515 H.P. units installed in Brown-Forman Distillers Corporation, Louisville, Ky. Plant.

**HENRY VOGT MACHINE CO. • 1000 W. Ormsby St., Louisville 10, Ky.**
**Branch Offices: New York, Philadelphia, Cleveland, Chicago, St. Louis, Dallas**



# DON'T LET THE SANDS OF TIME SHORTEN THE LIFE OF YOUR DIESELS

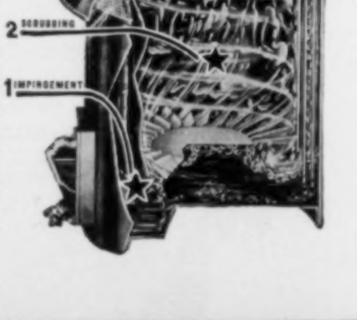
The millions of abrasive dust particles contaminating all air are a constant menace to the smooth operation and long life of engines and compressors unprotected by efficient air cleaners. Industry in general knows this and regards an expenditure for good air cleaning equipment—a sound investment. The Cycoil Cleaner with its 4 way cleaning operation is unsurpassed for cleaning efficiency.

Six tests, for instance, made in accordance with the standard test code of the A. S. H. V. E. using Fuller's Earth with an average particle size of 3 microns, revealed that the Cycoil Cleaner had a dust removal efficiency of 99.91% at full capacity—.09 of a percent from perfection!

If your diesels, gas engines or compressors lack protection there's an AAF filter designed to meet your specific needs. Write for free descriptive bulletins.

**AMERICAN AIR FILTER COMPANY, INC.**
408 CENTRAL AVE., LOUISVILLE, KY.
IN CANADA: DARLING BROS., LTD., MONTREAL, P. Q.

Cycoil Oil Bath Air Cleaner provides 4 way cleaning — Impingement, Scrubbing, Cyclonic Action and Filtering.



Filtration thru Double Cells completes cleaning action eliminating oil mist from air.

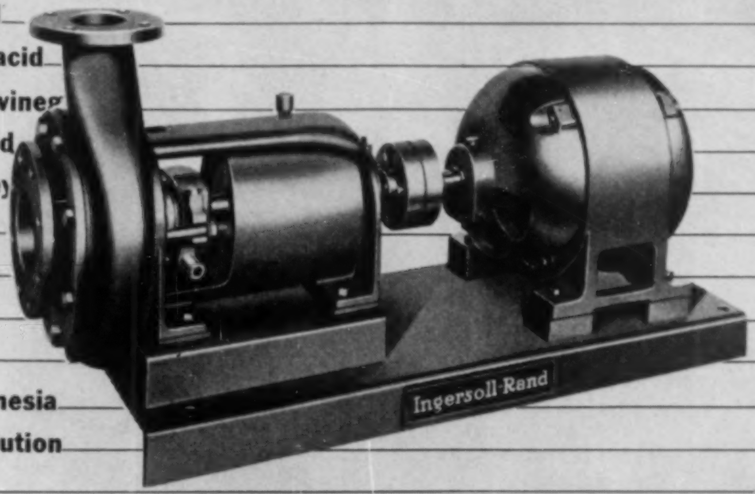
Cyclonic action induced by vanes throws oil containing dust outward.

Scrubbing action thoroughly mixes air and oil, entraining all dust particles.

Impingement of dirty air against oil, deposits the heavier dust particles immediately. Oil and air mixture then passes upward with whirling motion thru vanes to succeeding cleaning steps. Cycoil bulletin No. 130 D gives complete information.

AAF Cycoil OIL BATH AIR CLEANER
AND INTAKE SILENCER

# DOCTOR OF pH



| pH | Water solution | H ion conc. g-mol/l |
|---|---|---|
| 0 | hydrochloric acid | 1.0 |
| 1 | sulfuric acid | .1 |
| 2 | phosphoric acid | .01 |
| 3 | acetic acid (vineg | .001 |
| 4 | carbonic acid | .0001 |
| 5 | boric acid (ey | .00001 |
| 6 | milk | .000001 |
| 7 | pure water | .0000001 |
| 8 | baking soda | .00000001 |
| 9 | borax | .000000001 |
| 10 | milk of magnesia | .0000000001 |
| 11 | ammonia solution | .00000000001 |
| 12 | lime | .000000000001 |
| 13 | washing soda | .0000000000001 |
| 14 | caustic soda (lye) | .00000000000001 |

Degrees come the hard way in the corrosive field. They mean years of lab research and more years of field testing. I-R chemical pumps have plenty of both behind them. They have what it takes to run the whole pH scale with distinction in any chemical plant.

These features contribute to the success of I-R chemical pumps:—

**"IRCAMET",** a special corrosion-resistant alloy, containing high chromium and nickel with molybdenum and low carbon, that has proved itself on a long list of corrosives. (Other materials available for special services.)

**HYDRAULIC DESIGN** that results in the utmost in economy and power savings.

**"LEAKOLLECTOR",** the new I-R patented gland, collects all stuffing-box leakage and leads it to a convenient point.

**"CAMERON SHAFT-SEAL"**— I-R pumps may be equipped with this modern solution to stuffing-box problems that is the talk of the pump world. It is the mechanical seal that *really* performs its function.

Learn more about I-R chemical pumps from an I-R engineer near you who will gladly help you with your problems. Ask for chemical pump catalog No. 7095 and Shaft Seal bulletin No. 7100.

SEVENTY-FIFTH ANNIVERSARY

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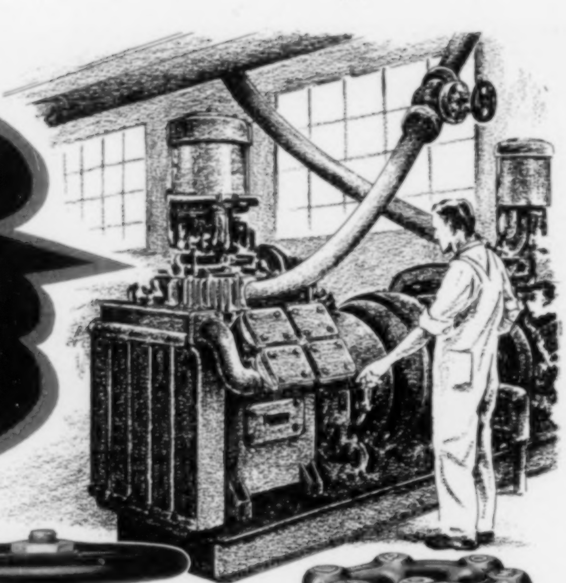
CAMERON PUMP DIVISION

10-931

# VALVES designed for Compressed Air Services



Years ago, when American Industry was still in its infancy, The Wm. Powell Company adopted a definite, farsighted policy . . . to concentrate on making valves only—valves of *every* design, for *every* service in *every* branch of industry.

That is why, today, Powell can supply valves to meet every requirement of the compressed air services, including all types necessary for controlling water for cooling compressors. And if any new demands arise, Powell Engineers will design valves to meet them.

Catalog covering the Powell Line of Valves for Compressed Air Services furnished on request.

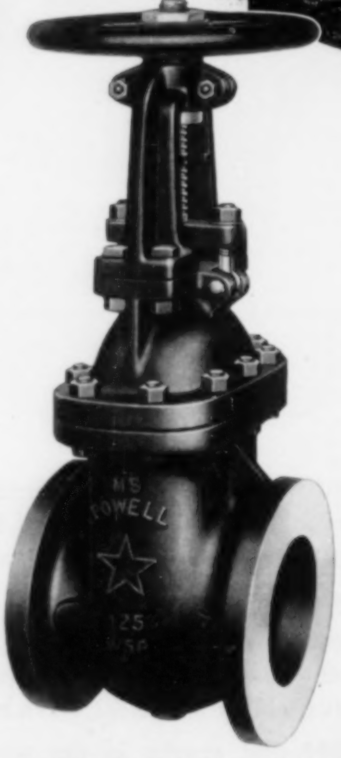


**Fig. 1793**—125-pound Iron Body Bronze Mounted Gate Valve with flanged ends, outside screw rising stem, bolted flanged yoke, bronze seat rings and taper wedge solid disc. Also available in All Iron.

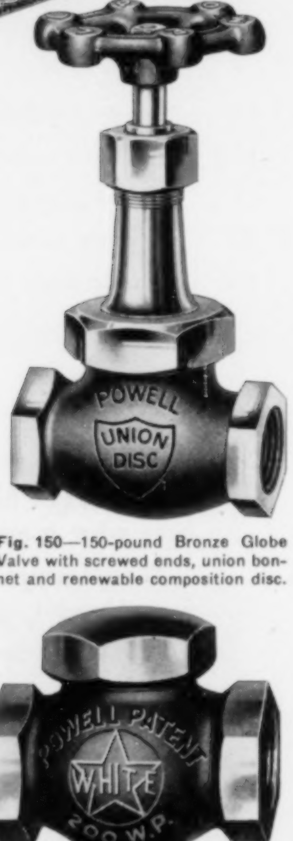


**Fig. 150**—150-pound Bronze Globe Valve with screwed ends, union bonnet and renewable composition disc.

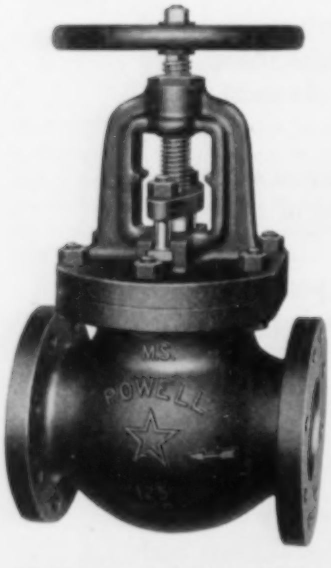


**Fig. 241**—125-pound Iron Body Bronze Mounted Globe Valve. Has flanged ends, outside screw rising stem, bolted flanged yoke and regrindable, renewable bronze seat and disc. Also available in All Iron.

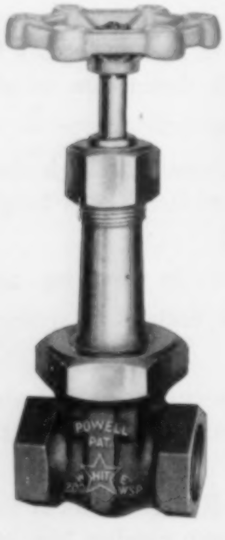


**Fig. 375**—200-pound Bronze Gate Valve with screwed ends, inside screw rising stem, union bonnet and renewable, wear-resisting "Powellium" nickel bronze disc.

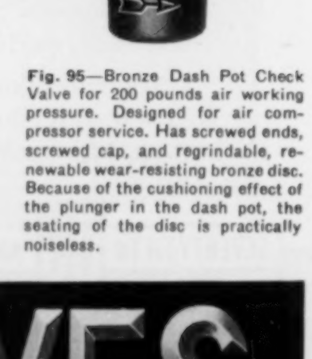


**Fig. 95**—Bronze Dash Pot Check Valve for 200 pounds air working pressure. Designed for air compressor service. Has screwed ends, screwed cap, and regrindable, renewable wear-resisting bronze disc. Because of the cushioning effect of the plunger in the dash pot, the seating of the disc is practically noiseless.

**The Wm. Powell Co., Cincinnati 22, Ohio**

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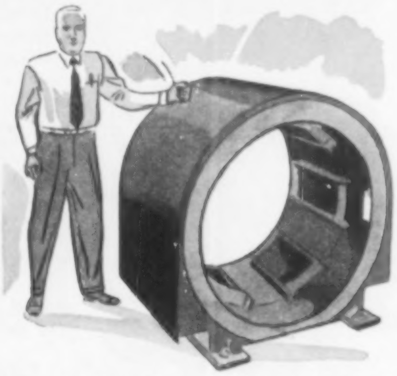
# POWELL VALVES

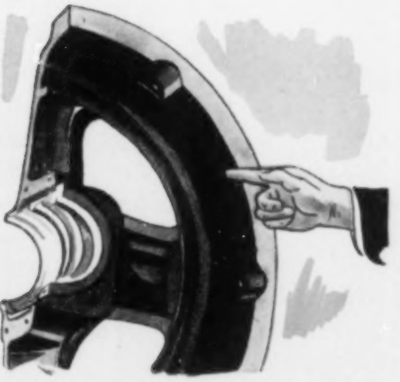
"You Never Saw Such Trouble-free Motors..."
ALLIS-CHALMERS

**Which Is Another Way** of saying they *stand up better* than any other make we've used on this job!" Strong words, but they describe exactly how this customer feels about the 500-hp, open type, bracket bearing Allis-Chalmers motors he started using back in '35.

**Since Then He's Ordered 14** *identical* motors for mine pump service! Yes, in almost every industry you'll find these 250 hp and up, medium and high-speed motors paying their way on toughest drives. A check into several of their unusual features will reveal *why*.



**Take Yokes,** for example. *Steel,* not cast iron. Result: they've got more strength, feet won't break off, there are no projections inside or out to catch dirt. Furthermore, yokes are solid . . . have no openings to admit dust or dirt during non-operating periods.



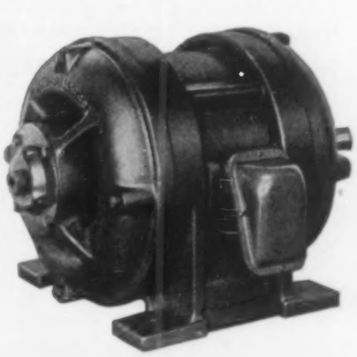
**And Bearing Brackets** are *extra*-deep . . . giving greater protection to stator winding coil ends. They're oil leak-proof too. Further, these motors are quiet in operation. Liberal air paths keep air velocities low. Enclosed type yokes reduce noise. Magnetic noise is kept to a minimum. *Yes, from every angle, A-C builds quality into motors!*

## "A-C" Means Quality — Clear Through!

SMALL OR LARGE, in a range of 1 to 7,000 hp, you're *sure* of top quality when you specify Allis-Chalmers motors!

Check their rigid, distortionless stators . . . their tough insulation specially treated to resist deterioration, moisture and mild acids . . . their long-life rotors . . . their rigid frames that keep bearings protected and in perfect alignment.

For the *full* story of liberal Allis-Chalmers construction, get in touch with your nearby A-C dealer or sales office. ALLIS-CHALMERS, MILWAUKEE 1, WIS.



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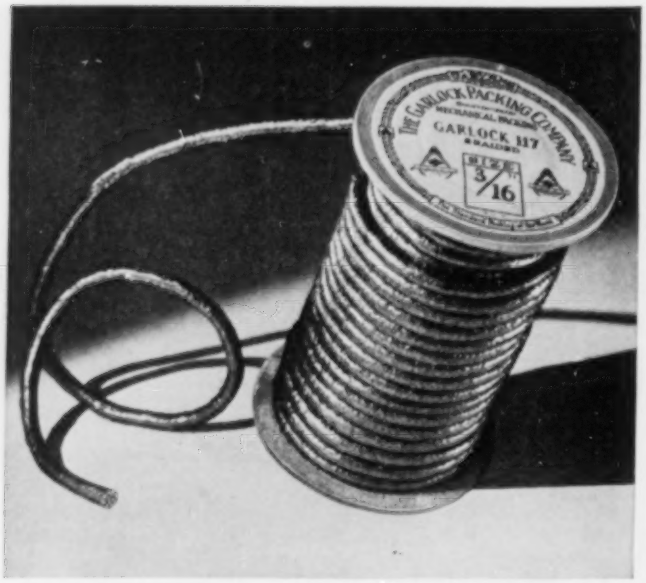
A 2118



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Quality controlled from raw materials to finished product—each ingredient, each process, each operation is checked to conform with the Garlock standard of quality. Result: Garlock 117 gives dependable service day in and day out, lasts longer and lowers maintenance costs. Specify Garlock 117 for globe and angle valves operating against high or low pressure steam, hot or cold water, or oil.

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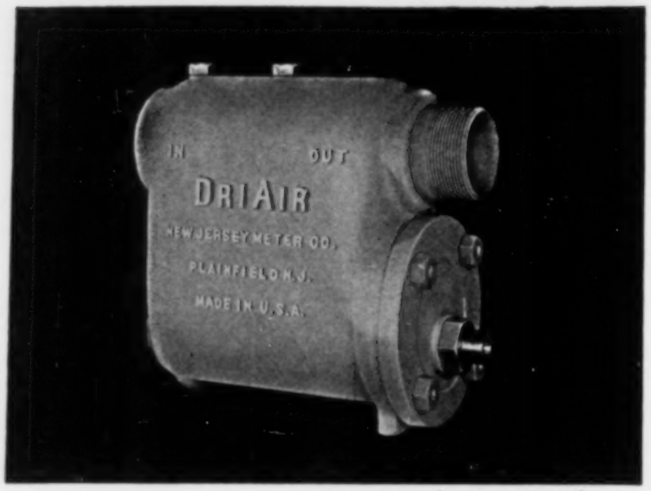
# GARLOCK 117

# DEPENDABLE PNEUMATIC SERVICE



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# DRIAIR

## A COMPLETE SELF-CONTAINED UNIT

**DriAir may be installed by suspending it from the piping, without any other support, or may stand on the floor near equipment being protected.**

DriAir speeds production by separating and automatically ejecting the condensed water and oil from the air. DriAir collects dirt and rust from the air lines and delivers clean dry air to the tools, thus reducing wear and prolonging their life. All internal parts are made of bronze or copper – resistant to corrosion and practically permanent. Copy of Bulletin DA fully describing the operation of DriAir sent on request.

# NEW JERSEY METER COMPANY

PLAINFIELD, NEW JERSEY

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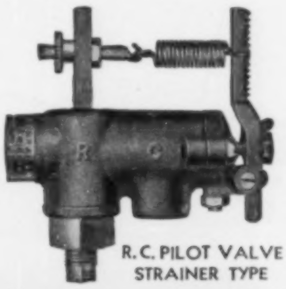

R.C. PILOT VALVE STRAINER TYPE

**R. CONRADER CO.**
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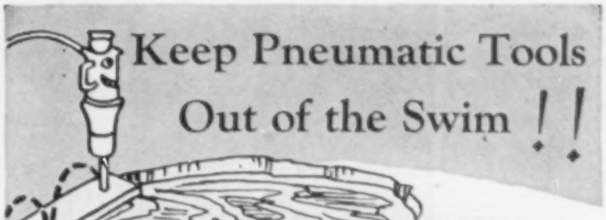
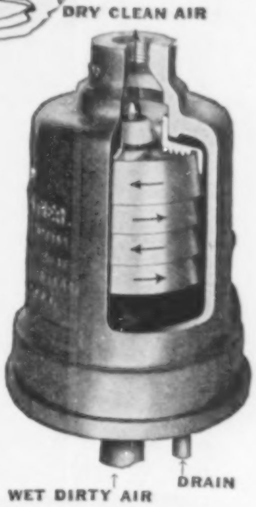


# Keep Pneumatic Tools Out of the Swim !!



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**Logan ARIDIFIER**
Dries and Cleans Compressed Air

REMOVES OIL WATER DIRT

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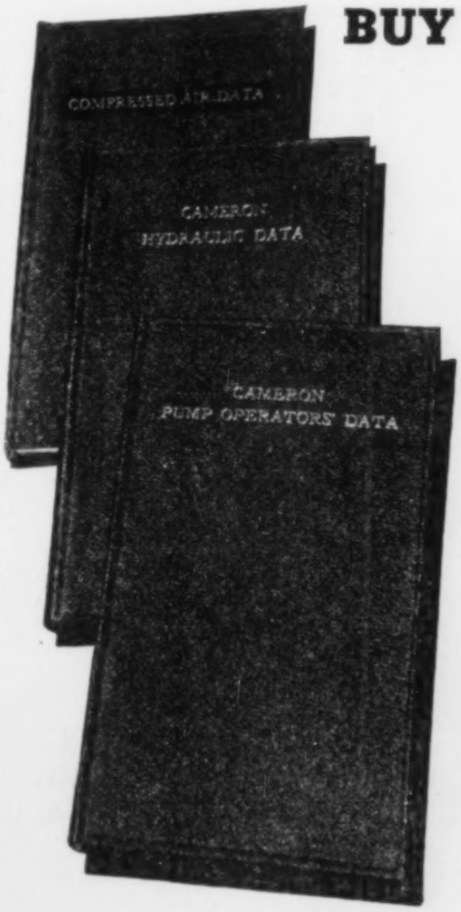

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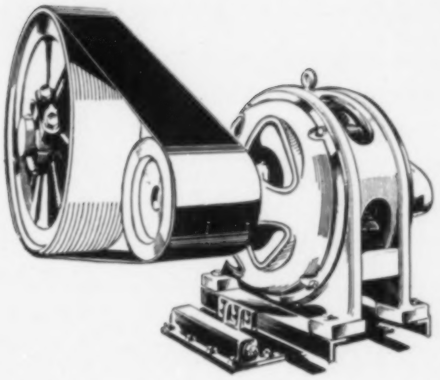

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HAMILTON, OHIO, U.S.A.
*Moisture Elimination Up To 3000 Pounds Per Square Inch*

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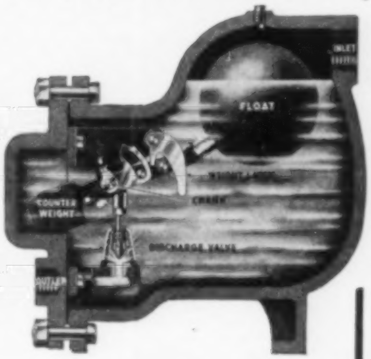

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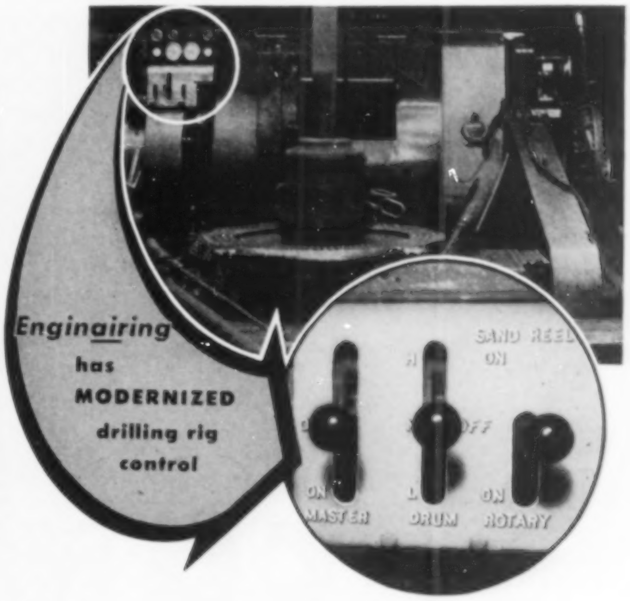

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Another big advantage is in the engine throttle control. W·A·B· devices permit a group of engines to be accurately and automatically load-balanced when compounded. This assures the most efficient utilization of available power, and eliminates the excessive wear and maintenance that may result when engines do not share the load. A change from compound to individual engine operation can be made in a moment.

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WABCO PACKING

**WESTINGHOUSE AIR BRAKE COMPANY**
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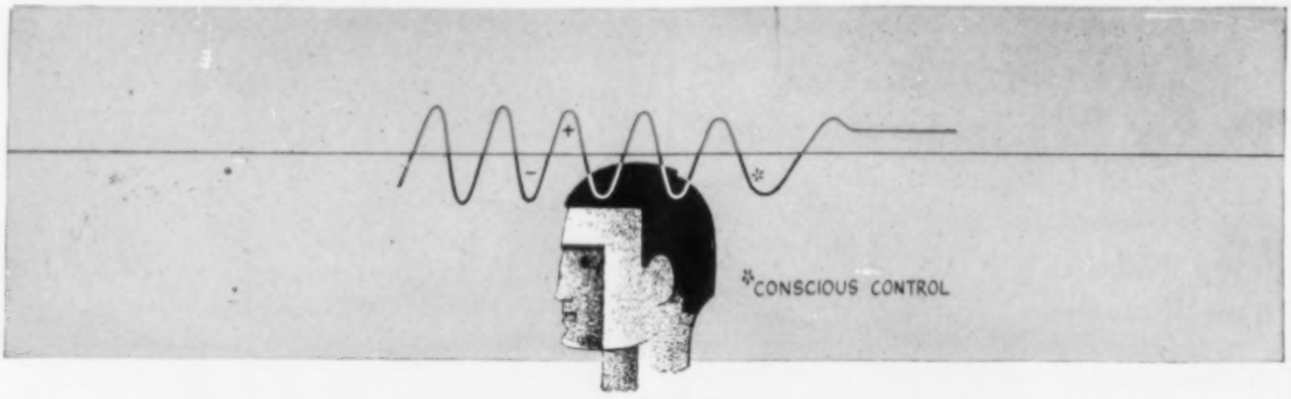
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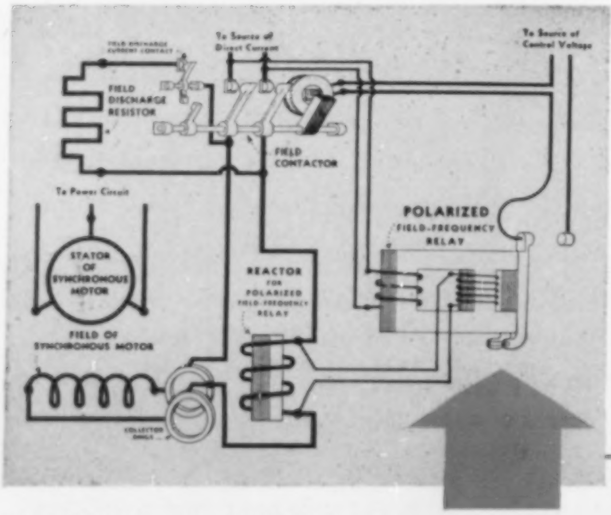
*CONSCIOUS CONTROL

# SYNCHRONOUS MOTOR CONTROL

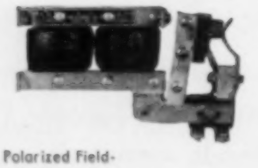
## THE E-M POLARIZED FIELD-FREQUENCY WAY!


Field Discharge Current Contact
To Source of Direct Current
To Source of Control Voltage
FIELD DISCHARGE RESISTOR
FIELD CONTACTOR
To Power Circuit
STATOR OF SYNCHRONOUS MOTOR
POLARIZED FIELD-FREQUENCY RELAY
REACTOR FOR POLARIZED FIELD-FREQUENCY RELAY
FIELD OF SYNCHRONOUS MOTOR
COLLECTOR RINGS

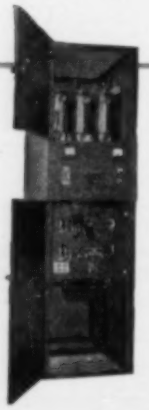
BACK of the smooth, trouble-free starting and dependable performance of E-M Synchronous Motors is a simple, yet highly sensitive, automatic control whose response under all conditions of operation seems almost humanly "conscious." It's called the E-M *Polarized Field-Frequency Control.*

In automatically applying excitation during starting, this control is sensitive to rotor position as well as best motor pull-in speed. As a result, excitation is applied when the rotor of the motor is in *best* position for maximum synchronizing torque. Pulling into synchronous speed is thus smooth, fast, and causes least line disturbance. In addition, resynchronizing is prompt and dependable in case motor gets out of step due to a voltage dip.

**DIAGRAM** shows simple E-M field control system. Induced alternating current from synchronous motor field winding, and direct current from excitation source, operate Polarized Field-Frequency Relay (right). Provides best synchronizing and resynchronizing of the synchronous motor under all conditions of operation.



Polarized Field-Frequency Relay



**TYPICAL** of high-quality E-M controls is the 2300-volt "Hi-Fuse" Starter at left. Provides correct, dependable starting and includes short-circuit protection. E-M controls are available in many types. *Ask the E-M engineer in your territory for further information.*

**WRITE TODAY!** Get your copy of new 20-page booklet ..."ABC of Synchronous Motor Control."

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*Minneapolis 13, Minnesota*

SPECIALISTS IN SYNCHRONOUS MOTORS FOR INDUSTRIAL DRIVES

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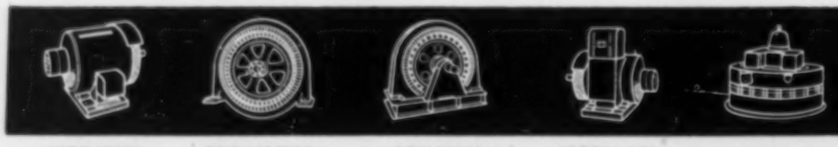

HIGH-SPEED ENGINE-TYPE LOW-SPEED "PACKAGED" VERTICAL

A2001

From start-up
...to shut-down
12
1
2
3
4
6
7
8
9

# ROCK DRILLS NEED AN OIL THAT DOES 5 JOBS

IT'S the start of the shift—the drill is cold. Here's Job No. 1 for the oil you use: low-temperature fluidity for easy starting . . . for "full throttle" drilling without delay.

As the drill warms up, it demands that the oil, (2) lubricate safely despite extreme shock loads, (3) resist oxidation which would result in gum and carbon formation, (4) form a water-oil emulsion that will give lubrication even though excessive amounts of water get into the drill.

With the end of the shift, you're ready to stop, but the oil in the drill must go *right on working.* That's because Job No. 5 is protection—rock-drill oil must have high metal-wetting ability to prevent rusting of the precision-ground parts of the cylinder and valves, especially when the tool is idle.

Does this sound exacting? It is. This is a job for Shell Clava Oil—an oil that is specially handled, from crude selection through final compounding, for superior service in percussion air tools.

The Shell Lubrication Engineer will give you advice about the lubrication of any compressed air equipment. For informative literature, write Shell Oil Company, Incorporated, 50 West 50th St., New York 20, N. Y.; or 100 Bush St., San Francisco 6, Calif.

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